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Comparative Analysis of The Techniques of The Top Eight Men's Javelin Throwers at the London World Championships

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Abstract

There is a significant gap between China and other countries in javelin events. How to improve the competitive level and performance of Chinese javelin athletes is an urgent problem to be solved. This paper takes the technical comparative analysis of the top eight men's javelin throwers at the London World Championships as the research object, and studies the technical characteristics of the top eight men's javelin throwers at the London World Championships in 2017. Four research methods are used: literature, expert interview, video analysis and mathematical statistics. Conclusion: The first eight male athletes hold guns at the stage of holding guns; The run-up distance of excellent athletes shows a trend of gradually shortening; On the whole, the first athlete in the throwing stage has a good effect on the use of the step time, the first three athletes have a stable step time, and the third to eighth athletes have a poor performance; The release speed of the top eight male athletes in the final exertion stage showed a gradual downward trend.

Keywords

London World Championships; Javelin competition; Men's javelin throwers; Technical comparison.

1. INTRODUCTION

Javelin is a sport with a long history. Compared with the development of foreign javelin projects, China's javelin projects have made some progress since 1980. However, in recent years, there is a significant gap between China and other countries in javelin projects. This paper makes a comparative analysis of the skills of the top eight male javelin throwers in the London World Championships in order to deeply understand the technical characteristics of Chinese male javelin throwers and analyze the gap between them and the world's top male javelin throwers. The research can provide more abundant theoretical basis for the further study of javelin throwers' technology and build a more perfect theoretical system. This paper obtains the technical parameters of outstanding athletes in the competition through video analysis, and analyzes and summarizes the technical characteristics of the top eight athletes, providing certain direction and reference for coaches and javelin athletes' future technical training, narrowing the gap between the level of Chinese men's javelin events and the world level, and providing scientific reference and reference for the improvement of Chinese javelin athletes' technology and the further development of javelin events.

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2. RESEARCH OBJECTS AND METHODS

2.1. Research object

This paper mainly takes the technical comparative analysis of the top eight men's javelin throwers at the London World Championships as the research object, and observes and studies the technical characteristics of the top eight men's and women's javelin throwers at the 2017 London World Championships.

2.2. Research methods

2.2.1 Literature method

According to the purpose and content of the study, through the library's access to publications, books, magazines, newspapers and other relevant materials, we have a more comprehensive understanding of the current research situation in this research field, and carefully read and collate the literature, which provides an important theoretical basis for the writing of this article.

2.2.2 Expert interview method

In order to make the research more representative and referential, on the premise of consulting the literature, it is planned to conduct a purposeful, planned and targeted interview with javelin experts, scholars and professors in the form of interviews, discuss the main content and research methods of this subject, understand the technical characteristics of male athletes and excellent javelin athletes, and conduct research methods, theoretical structure The methods and contents of data statistics shall be adjusted and modified.

2.2.3 Video analysis method

Through watching the video of the 2017 London World Athletics Championships, making statistics on the results of the top eight men's javelin throwers, using video editing software to process the video of the 2017 London World Athletics Championships javelin throwers, using fast feedback systems such as dartfish, Haojie V8 to capture, edit and measure the angle of the video, laying a data foundation for the study of technical characteristics in this paper.

2.2.4 Mathematical statistics

Conduct mathematical statistics on the data obtained from video observation to obtain first-hand information, and use the data obtained from video observation. Analyze and discuss the data obtained objectively and deeply, get the information related to the paper, and put forward reasonable suggestions on this basis.

3. RESULT

3.1. Analysis of the characteristics of technology application in the stage of holding a gun

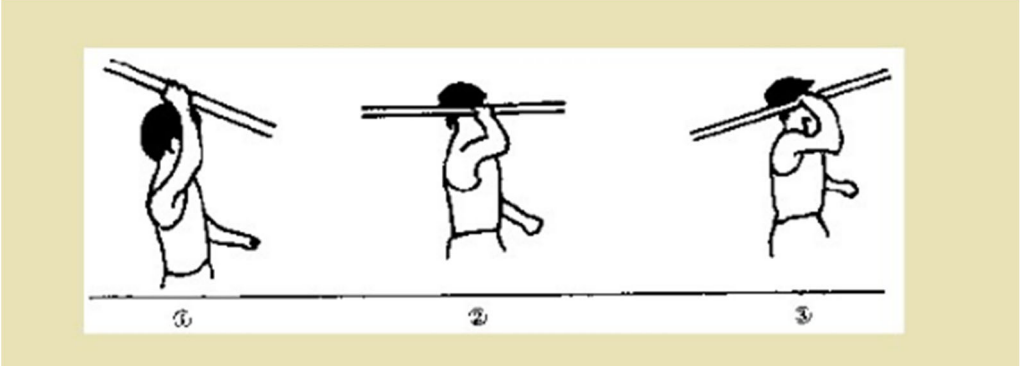

Figure 1. Javelin with gun on shoulder

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Figure 2. Javelin held under shoulder

In javelin sport, the application of the technology in the stage of holding the gun is to help play and reflect the speed requirements in the run-up stage, which has a positive impact on the play of the action of drawing the gun. There are three main actions of holding a gun, namely, holding a gun on the shoulder, holding a gun under the shoulder and holding a gun on the flat shoulder, as shown in Figure 1 and Figure 2. Among them, the athletes in the javelin movement carry guns on their shoulders, and most people use this kind of action. Shoulder gun holding means that the athlete holds the javelin under his shoulder and leans the javelin under his arm. Shoulder gun holding requires the athlete to turn right to make overtaking action from run-up to the first few steps of throwing, and then raise the throwing arm to throw. Although it is used by athletes, it is not common. The action of holding the javelin on the flat shoulder requires the athlete to put the javelin behind in advance, the javelin is about as high as the shoulder, face the direction of the javelin throw sideways, and then run forward, and gradually surpass the step before the throw, and then lead to the throw. The number of people who use this kind of gun-holding action is even less, because such gun-holding action will not only affect the speed of running, but also affect the coordination of athletes' movements. According to the research needs of this paper, the video of the top eight men's javelin throwers at the 2017 World Championships in London was watched, and the holding methods of the eight men's javelin throwers during the holding stage and the angle between the big and small arms during the technical application were statistically analyzed.

Table 1. Statistical table of the action of the top eight male athletes with guns

Name	Gun on shoulder	Gun under shoulder	Flat shoulder Gun
Johannes VETTER	√	×	×
Jakub VADLEJCH	√	×	×
Petr FRYDRYCH	√	×	×
Thomas ROHLER	√	×	×
Tero PITKAMAKI	√	×	×
Ioannis KIRIAZIS	√	×	×
Keshorn WALCOTT	√	×	×
Andreas HOFMANN	√	×	×

From Table 3, it can be seen that the top eight male javelin athletes in the 2017 London World Championships held a gun on their shoulders during the stage of holding a gun. The elbow joint of the athlete's arm is slightly higher than the shoulder, the hand holding a gun is slightly higher

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than the head, and the sharp head position of the javelin is lower than the tail of the javelin. This kind of holding a gun has a positive effect on the relaxation of the wrist and the extension of the movement of the athletes, Most javelin throwers will use this way of holding a gun on their shoulders.

Table 2. Statistical table of the results of technical application of the top eight male athletes at the stage of holding guns

Name	Arm angle	Score (m)
Johannes VETTER	90°	89.89
Jakub VADLEJCH	89.5°	89.73
Petr FRYDRYCH	89.3°	88.32
Thomas ROHLER	87.2°	88.26
Tero PITKAMAKI	86.9°	86.94
Ioannis KIRIAZIS	85.6°	84.52
Keshorn WALCOTT	85.3°	84.48
Andreas HOFMANN	84.7°	83.98

Table 4 shows the results of the angle between the big and small arms of the top eight male athletes in the process of holding the gun. Table 3 shows that the top eight male athletes hold the gun on their shoulders and bend their arms to hold the gun on their shoulders. According to relevant research data, the reasonable range of the angle between the big and small arms of the athletes in the technical action of holding the gun on their shoulders is about 90 degrees. The first place is that the angle between the big arm and the small arm of the gun on the shoulder is 90 degrees, which is within a reasonable range; The angle between the second and third athletes' arms and arms is close to 90 degrees at the stage of holding the gun; There is a certain gap between the angle formed by the angle between the upper arm and the lower arm of the fourth to eighth athletes at the stage of holding a gun and 90 degrees. That is to say, the angle formed by the angle between the big arm and the small arm has a certain impact on the javelin throwing results. The better the angle formed between the big arm and the small arm is, the better the effect of the javelin shot in the subsequent throwing step stage and the final force stage will be. At the same time, it has a certain relationship with the physical quality of the athletes. At the stage of holding the gun, the athletes need to have strong strength in the shoulder arm, which will have a positive impact on the formation of the best angle between the big arm and the small arm.

3.2.2 Analysis of technical application characteristics in run-up stage

There are two ways for athletes to throw javelin in the run-up stage. One is that athletes gradually accelerate in the run-up process, and the other is that athletes actively accelerate in the run-up process. Gradual acceleration refers to the gradual acceleration of the athletes from the slow speed at the beginning to the run-up and then to a certain level of speed, which can lay a speed foundation for the final exertion stage. Active acceleration means that the athlete accelerates actively and quickly from the start of the run-up to achieve the goal of improving speed in a short time, and then enters the javelin throwing step stage. No matter which approach is used, the athletes should use the most basic level running technique before the throw step stage.

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Table 3. Statistical table of technical application of the top eight male athletes in the run-up stage

Name	run-up distance (m)	starting speed (m/s)	maximum speed (m/s)	right foot landing speed (m/s)
Johannes VETTER	26.3	0.84	7.49	5.34
Jakub VADLEJCH	26.7	0.80	7.46	5.84
Petr FRYDRYCH	26.9	0.94	7.51	6.20
Thomas ROHLER	27.6	1.04	7.62	5.70
Tero PITKAMAKI	28.0	1.10	7.48	6.21
Ioannis KIRIAZIS	28.9	1.21	7.47	5.89
Keshorn WALCOTT	28.4	1.45	7.31	5.47
Andreas HOFMANN	28.1	1.69	6.84	6.21

Table 5 shows the statistical results of the technical application of the top eight male athletes in the run-up stage. The application of the run-up technology is to better help the athletes complete the javelin throwing action. Among them, we can see that the run-up distance from the first athlete to the eighth athlete is gradually increasing, and the run-up distance of the elite athletes is gradually shortening. In the javelin competition, the maximum speed of the run-up can be maintained at about 70%. If the maximum speed is too fast, the athletes will not have time to complete a series of complex technical actions in the subsequent stages, reducing the final throwing effect. Javelin athletes need to achieve the speed they need in a relatively short run during the run-up. Too long run-up distance will cause athletes to consume some unnecessary physical energy. There is an acceleration process from the starting speed of the run-up to the maximum speed. The speed effect of the whole process has a certain relationship with the athlete's physical quality and technical level. Therefore, this requires javelin athletes to speed up the formation of run-up according to their physical quality and skill level.

3.2.3 Analysis of technical application characteristics at the stage of throwing step

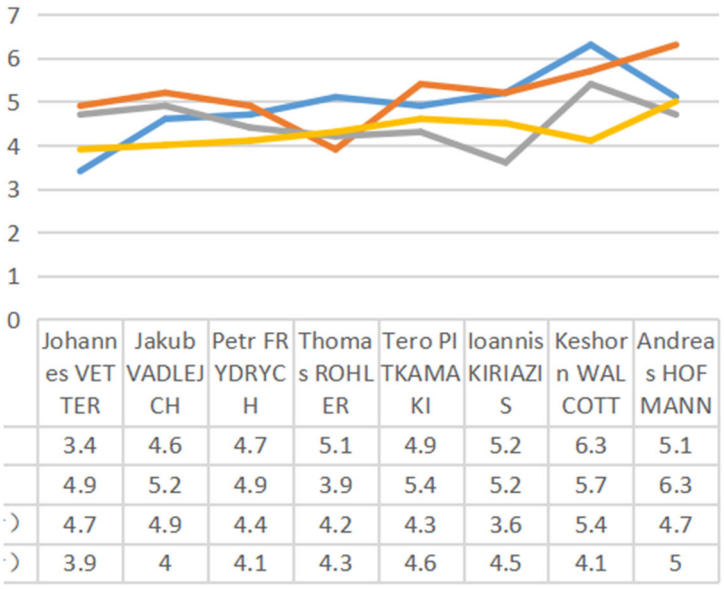

Figure 3. Schematic diagram of the use of stride frequency of the top eight men's athletes at the 2017 World Championships in London

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Figure 5 shows the comparative effect of the step frequency of the top eight male javelin athletes in the 2017 London World Championships. It can be seen that the step frequency of the first, second, third, fifth and eighth athletes in the first step to the second step of the throwing step is increasing, that is to say, these athletes have been accelerating in this stage. The step frequency of the fourth and seventh athletes in the first step to the second step of the throwing step obviously showed a downward trend, with a relatively obvious decline value of 1.2 and 0.6, respectively, which clearly showed that the two athletes slowed down at this stage. There is a common phenomenon among the top three excellent athletes in the first and second stages of the throwing step, that is, the step frequency of the two throwing steps is relatively fast, the step frequency of the third step is relatively slow, and the fourth step is the slowest, which has a direct relationship with the step length and step length of the athletes. In the third step of the throwing step in the throwing stage of javelin competition, the requirement for the step frequency is to be slow, so that the energy can be reserved for the athletes in the final stage and the maximum force effect can be exerted. Compared with the slowness of the third step, the fourth step requires the athletes to have the fastest pace. This is to enable the athletes to complete the braking action with the fastest speed, and to be fully prepared for the formation of the final high-quality whip action. The slow step frequency of the fourth step of the throwing step indicates that the brake effect of the left leg forward extension of the athlete in the fourth step is not good and the initiative is not high.

3.2.4 Analysis of technical application characteristics in the final exertion stage

The final force stage of javelin movement can be divided into four parts, as shown in the figure above: 1. The landing time of the last step of the athlete's left foot in the throwing step; 2. Braking step back landing time; 3. The "full bow" time of javelin throwing; 4. Javelin shooting time. This stage division is relatively reasonable.

By watching the video of the top eight men's javelin athletes at the 2017 World Championships in London, this paper studies the comparative situation of the technical application in the final force stage of javelin, and makes a statistical analysis of the athletes' release speed and the physical technical application in the final force stage.

3.2.4.1 Release speed

In the final force stage of javelin competition, the release speed of the javelin is mainly the speed at which the javelin leaves the athlete's hand. The transmission effect of the whole body energy determines whether the release speed is fast or slow. The transmission process starts from the lower limb to the ground, then to the lower limb to the body trunk, then to the arm throwing the javelin, and finally to the javelin, in this order, The energy transfer of the whole javelin technical action is completed, but the energy transfer is also inseparable from the connection between each link of technical action. The speed of the javelin throw is the key factor to achieve the perfect throwing effect. The athletes participating in the javelin throw competition will pursue the maximization of competition benefits in the throwing stage, making it more conducive to their own victory in the competition. The speed of the javelin throw is also in the pursuit of the maximization of competition benefits.

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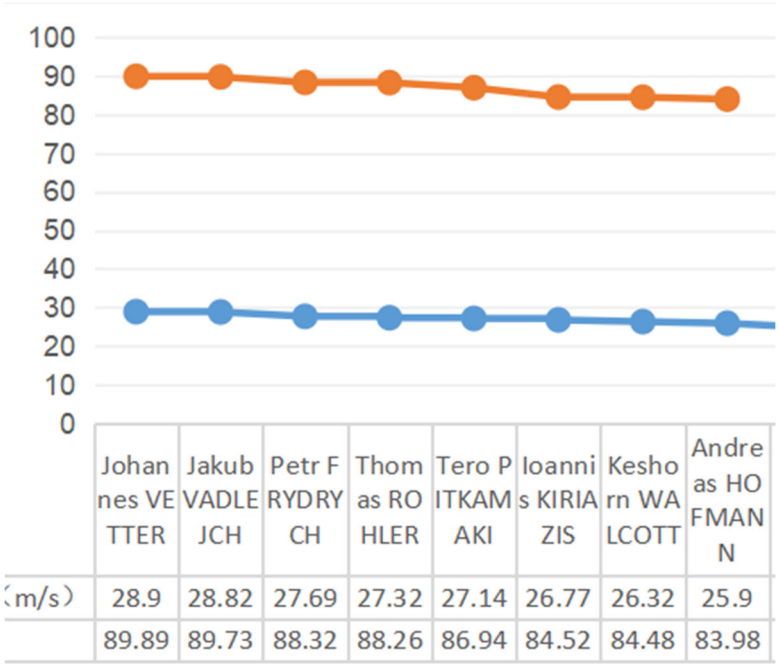

	Johannes VETTER	Jakub VADLEJCH	Petr FRYDRYCH	Thomas ROHLER	Tero PITKAMAKI	Ioannis KIRIAZIS	Keshorn WALCOTT	Andreas HOFMANN
(m/s)	28.9	28.82	27.69	27.32	27.14	26.77	26.32	25.9
	89.89	89.73	88.32	88.26	86.94	84.52	84.48	83.98

Figure 4. Schematic diagram of the release speed of the top eight male athletes in the final force stage

Figure 7 shows the statistical results of the release speed of the top eight male athletes in the final force stage of the Javelin Javelin Championships in London in 2017. It can be seen that the release speed of the top eight male athletes is gradually declining in the application of technology in the final force stage. Johannes VETTER, the player who won the first place, has the highest speed of release, with a release speed of 28.90 meters/second, so his corresponding race result is 89.89 meters; The second player's javelin release speed was 28.82 meters/second, and the corresponding result was 89.73 meters; The javelin shooting speed of the third player was 27.69 meters/second, and the corresponding competition result was 88.32 meters; By analogy, the eighth player's release speed is 25.90 meters/second, and the corresponding race result is 83.98 meters. In the javelin competition, the speed of the javelin shot of the athlete is in direct proportion to the distance of the javelin flying in the air. According to the relevant research, the javelin flying distance will increase by 5 meters per second for every increase in the speed of the javelin shot. The faster an athlete releases his javelin, the better his performance will be. From the comparison of the javelin release speed and the corresponding results of the previous eight male athletes, it is consistent with the theory that the javelin release speed and the javelin flight distance are positively correlated. Javelin release speed is composed of vertical speed and horizontal speed generated at the moment of javelin release. The vertical speed and horizontal speed generated at the moment of javelin release determine the speed generated at the moment when the javelin leaves the athlete's hand. That is to say, the vertical speed and horizontal speed generated at the moment of javelin release determine the athlete's final performance.

3.2.4.2 Technical analysis of the right side of the body in the final exertion stage

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Table 4. Analysis of the right side technique application of the top eight male athletes in the final exertion stage (degrees)

	Right foot landing time		Left foot landing time		Full bow time		Release time	
	Elbow joint	Shoulder joint	Elbow joint	Shoulder joint	Elbow joint	Shoulder joint	Elbow joint	Shoulder joint
Johannes VETTER	155°	89°	146°	90°	140°	89°	160°	142°
Jakub VADLEJCH	152°	88°	140°	89°	138°	88°	156°	138°
Petr FRYDRYCH	149°	87°	137°	88°	129°	86°	154°	133°
Thomas ROHLER	146°	86°	140°	85°	135°	85°	170°	140°
Tero PITKAMAKI	153°	84°	130°	81°	121°	83°	152°	130°
Ioannis KIRIAZIS	122°	82°	125°	80°	119°	78°	159°	132°
Keshorn WALCOTT	127°	79°	123°	77°	120°	78°	156°	129°
Andreas HOFMANN	130°	78°	122°	76°	117°	80°	167°	145°

From Table 9, we can see the results of the application of the right side technique of the top eight male athletes in the final exertion stage. The maximum angle between the body and the big arm of the world's top athletes is 90 degrees, which is what we call the shoulder joint angle. From the statistical results in the table above, the shoulder joint angle at the moment of the formation of the first Johannes VETTER's "full bow" technical action is 89 degrees, which is within the range of the shoulder joint angle of the world's top athletes, In the final exertion stage, the shoulder joint angle formed by the "full bow" movement of the top eight male athletes gradually weakened with the ranking of the competition, and gradually separated from the shoulder joint angle of the world's top athletes. That is to say, if the angle of the athlete's shoulder joint is reasonable, it can improve the stability of the athlete's javelin throwing. The formation of the athlete's "full bow" technical action is relatively good, which effectively shortens the exertion distance of the athlete at the final exertion stage, and reduces the effect of the final exertion stage. If it is not appropriate, the effect is opposite. At the final stage of exertion, the angles of the shoulder joints of the top three male athletes were 89 degrees, 88 degrees and 87 degrees respectively when the right foot landed, while the angles of the shoulder joints were 90 degrees, 89 degrees and 88 degrees respectively when the left foot landed, with an upward trend of 1 degree, but there was basically no significant change. However, the angle generated by the shoulder joint of the fourth to eighth male athletes during the final stage of exertion from the landing time of the right foot to the landing time of the left foot fluctuated significantly, showing a gradual downward trend, which affected the state of javelin flying in the air, and then had a negative impact on the distance of javelin flying. According to relevant research, the best angle range of elbow joint application in the final force stage of javelin throwing is between 145 degrees and 160 degrees, and a reasonable elbow joint angle has a key impact on the formation of athletes' "full bow" technical action and the quality of exceeding the instrument action. From the above table, it can be seen that the elbow joint angle of the first three male athletes is used within a reasonable range from the landing time of their feet to the landing time of their left feet, while the fourth to eighth male athletes use an unreasonable angle of the elbow joint at this stage and do not have a good control over the elbow joint. The left foot landing is not in the best range, which means that the athlete launched the javelin throwing action before the left foot landing, and the timing is improper, which will affect the final whip technical action. The change

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of elbow joint angle of the top eight male javelin throwers is increasing, which means that the athletes do the action of pulling the gun forward and upward more fully.

3.2.4.3 Technical analysis of the left side of the body in the final exertion stage

Table 5. Analysis of the left side technique application of the top eight male athletes in the final exertion stage (degrees)

	At the moment of landing of the left foot	The maximum bending moment of the left leg	The buffering angle of the javelin release	Cushion angle	Pedal angle
Johannes VETTER	170.65°	164.24°	171.51°	6.41	7.27
Jakub VADLEJCH	169.60°	162.87°	170.23°	6.73	7.36
Petr FRYDRYCH	168.64°	162.11°	169.36°	6.53	7.25
Thomas ROHLER	169.51°	166.14°	176.82°	3.37	10.68
Tero PITKAMAKI	166.53°	170.63°	175.73°	4.1	5.1
Ioannis KIRIAZIS	174.55°	160.45°	166.00°	14.1	5.55
Keshorn WALCOTT	176.27°	157.76°	163.55°	18.51	5.79
Andreas HOFMANN	169.23°	147.23°	152.11°	22	4.88
World average	172.33°	165.33°	173.67°	7	8.34

Note: The world average is quoted from Wen Chao's Advanced Course of Track and Field Sports Buffer refers to the knee joint angle from the moment of landing of the left foot to the moment of maximum bending. Pedal extension refers to the knee joint angle from the moment of maximum bending of the left leg to the moment of javelin release

From Table 10, we can see the application results of the left side techniques of the top eight male athletes in the final exertion stage. Among them, the buffering angles of the first, second and third place athletes are 6.41 degrees, 6.73 degrees and 6.53 degrees respectively, which are close to the world average. The pedaling and stretching angles are 7.27 degrees, 7.36 degrees and 7.25 degrees respectively, which are not much different from the world average, indicating that the left leg knee support effect of the three athletes is relatively good, The javelin flying distance is good, while the buffering angle and the pedaling angle of the fourth to eighth athletes fluctuate greatly, which is far from the world average. This shows that the left leg knee support is not good and the supporting force is not stable during the final exertion of these athletes, which further affects the transmission effect between the upper limb and the upper limb, so that the final exertion effect of the athletes is consumed too much.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusion

4.1.1 The top eight male athletes in the javelin competition at the 2017 London World Championships held the gun in the shoulder. The angle formed by the angle between the big arm and the small arm on the shoulder of the first Tevel is within a reasonable range; The angle between the second and third athletes' arms and arms is close to 90 degrees at the stage of holding the gun; There is a certain gap between the angle formed by the angle between the upper arm and the lower arm of the fourth to eighth athletes at the stage of holding a gun and 90 degrees.

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4.1.2 In the javelin competition of the 2017 World Championships in London, the run-up distance between the first and eighth athletes gradually increased, and the run-up distance of excellent athletes showed a trend of gradually shortening.

4.1.3 In the javelin competition of the 2017 London World Championships, Johannes VETTER, the first place in the throwing stage, was superior to the other seven in the application effect of the first step of the throwing step. In terms of the effect reflected in the first step of the throwing step, the first three athletes' application of the step time was in the best range, showing a stable state, and the application time of the first step of the third to eighth place throwing step was not in the best range, and the curve changed significantly.

4.1.4 The release speed of the top eight male athletes in the final force stage of the Javelin Javelin Championships in London in 2017 showed a gradual downward trend. In the final exertion stage, the shoulder joint angle formed by the "full bow" movement of the top eight male athletes gradually weakened with the ranking of the competition, and gradually separated from the shoulder joint angle of the world's top athletes.

4.2. Suggestions

4.2.1 At the stage of holding a gun, athletes need to have strong strength in their shoulders and arms, which will have a positive impact on the formation of the best angle between the big arm and the small arm.

4.2.2 Javelin throwers need to reach the speed they need in a relatively short run during the run-up. Too long run-up distance will cause athletes to consume some unnecessary physical energy. Therefore, this requires javelin athletes to speed up the formation of run-up according to their physical quality and skill level.

4.2.3 In javelin sport, there will not be a fixed value for the step of the athlete's throwing step, which has a great relationship with the different physical qualities, physical characteristics and technical style of the athlete, resulting in the different rhythm of the athlete's throwing step. However, on this basis, the athlete needs to pay attention to that the law of the throwing step cannot be changed, On this basis, try to find the proper rhythm of the throwing step and increase the chips for winning the game.

4.2.4 In the final force stage, the left side of the athlete's body has good left leg kicking and stretching ability, which has a positive role in improving the height of the athlete's body center of gravity, and can also fully increase the height of the javelin shot, and also enable the javelin to be thrown at the fastest speed in cooperation with the athlete's own reasonable shot angle.

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