Jakarta Asian Games Men's 20km Walking Championship and Runner-up Comparative Study of Technologies

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Abstract. As a competitive event in China, the walking race not only carries the task of vying for gold for the country in international large-scale events such as the Olympic Games and the World Championships, but also bears the responsibility to strengthen the people's physique and drive the people's enthusiasm for sports. It also reflects to a certain extent the important symbol of the development of a sports power into a sports power. Walking race is a technology-oriented endurance event. On the basis of good endurance, it is also subject to many rules and technical constraints, which also makes it difficult for athletes to obtain good results. With the development of competitive sports, men's 20km race walking is very fierce nowaday\textsuperscript{s}. The rise of Japan can be said to pose a direct threat to our men's 20km race walking. We can see that Japan's grasp of the key technologies of walking race is very in place, focusing on technology Details play a key role in improving athletic performance. In this paper, a comparative study of Kaihua Wang and Toshikazu Yamanishi, men of 20 kilometers from the Asian Games in Jakarta, is conducted by means of literature data analysis, image analysis, mathematical statistics and comparative analysis. The research shows that Kaihua Wang has a relatively large stride when walking at high and low speeds, but Kaihua Wang has uneven steps on the left and right. Although Kaihua Wang has a greater distance between the back pedal and the forward swing than Shanxi, he has an uneven force on the left and right legs. It is stronger than Shanxi Lihe and balance ability; when swinging at high and low speeds, the amplitude of upper limb swing is small, and the left and right are not balanced; Toshikazu Yamanishi and Hou Yi phenomenon are larger than Kaihua Wang, and when landing, Kaihua Wang has a small landing angle on the left and a large undulation distance on the head when supporting on the left.

Research Purpose

Based on a comparative analysis of the walking skills of the outstanding men's 20km race walking athlete Kaihua Wang and Japanese player Shanxi Lihe at the Asian Games, find out the technical deficiencies of Chinese athlete Kaihua Wang, and draw on some of the advantages of Toshikazu Yamanishi. Make Kaihua Wang's race walking technology breakthrough again and refresh the best results.

Research Objects and Methods

Research Objects

Taking the basic technology of Kaihua Wang, runner-up Toshikazu Yamanishi, the runner-up of the 20km men's 20km race in the 2018 Asian Games in Jakarta, as the research object, the analysis of their competition technology.
Table 1. Browsing Basic Information of Athletes.

| Name             | Date of birth | Height / m | Weight / kg | Competition results | best result |
|------------------|---------------|------------|-------------|---------------------|-------------|
| Kaihua Wang      | 1994/02/16    | 175 cm     | 65 kg       | 1:22:04             | 1:19:30     |
| Toshikazu Yamanishi | 1996/02/15  | 164 cm     | 54 kg       | 1:22:10             | 1:20:50     |

Research Methods

**Literature Method.** According to the research purpose and content requirements of this thesis, with the keywords of "walking race" and "technology," a search was conducted on China HowNet, and 406 articles were retrieved, and 5 journals were selected for reading. Books on race walking and technology, gain knowledge about race walking and technology, and provide a solid theoretical basis for this article.

**Image Analysis Method.** The Swiss Dartfish sports video technology and tactics analysis system was used to make analysis and analysis of the video data of the men's 20km race walking and runner-up of the Asian Games to improve the systematic and scientific nature of professional research.

**Mathematical Statistics.** The basic technical angle and distance of the athlete's movements were calculated using Excel 2003 to statistically organize the athletes' walking technical dynamics data to obtain basic data for research and analysis.

**Comparative Analysis Method.** Statistical analysis of the technical data of the two athletes during high and low speed walking was conducted to obtain the appropriate angles and distances to find out the technical advantages of Kaihua Wang and Toshikazu Yamanishi, and clarify the technical advantages and improvements of Kaihua Wang.

Statistical Analysis of Image Data

Use image analysis and data statistics to interpret the basic technologies of Kaihua Wang and Toshikazu Yamanishi at high and low speeds.

Through statistical analysis of technical data of Kaihua Wang and Toshikazu Yamanishi at the high and low speed walking stages of the Asian Games, biomechanical measurement methods were used to improve the basic technical movements of China's 20km race walking athletes and absorb the superior movements of other outstanding athletes.

Figure 1. Analysis of Biomechanical Data of Shanxi Lihe on the Ninth Lap at Low Speed and Fifth Lap on the High Speed.
Research Results

Step Size and Frequency

Table 2. Technical Phase Time Statistics.

| Name                | Step size (m) | Step frequency (step / min) |
|---------------------|---------------|-----------------------------|
|                     | high speed    | Low speed                   | high speed | Low speed |
|                     | left          | right                       | left       | right     |
| Kaihua Wang         | 1.22          | 1.19                        | 1.17       | 1.16      | 203       | 213.6      | 213 | 216.6 |
| Toshikazu Yamanishi | 1.16          | 1.15                        | 1.16       | 1.15      | 215.8     | 219.6      | 214 | 210  |

The relationship between stride length and stride frequency can directly affect the final performance during the whole race walking process, which affects each other and restricts each other. The athlete's stride length and stride frequency are closest to the standard data values to achieve the best results. Data analysis from Table 2, Kaihua Wang's high-speed walk is a single step of 1.22m left, the right single-step step is 1.19m, when walking at a low speed, the left single-step is 1.17m, the right single-step is 1.16m, and Toshikazu Yamanishi's high-speed walk is left The step length is 1.16m, the right single step is 1.15m, and the low single step is 1.16m, and the right single step is 1.15m. From the comparison of the single step, Kaihua Wang can walk at high and low speeds. The stride length is better than that of Toshikazu Yamanishi and belongs to stride players. Kaihua Wang’s left leg cadence is 203 steps / min when walking at high speed, the right leg cadence is 213.6 steps / min, and at low speed, the left leg cadence is step 213 Step / min, the right leg cadence is 216.6 steps / min, while Shanxi Lihe and high speed left leg cadence is 215.8 steps / min, the right leg cadence is 219.6 steps / min, and the low leg cadence is 210 at low speed Steps / min, the right leg cadence is 214 steps / min, Toshikazu Yamanishi walked at low speed to high speed, the left single step cadence increased by 1%, the right single step cadence increased by 4%, and the average increased by 2.5%, Kaihua Wang's left single step cadence increased by 5% from low speed to high speed, and the right single step cadence increased by 1.4% and an average increase of 3.2%. The single-step cadence is smaller than that of Toshikazu Yamanishi. The average cadence is increased by a large number in the process from low speed to high speed, and Kaihua Wang's left and right single-step cadence are not balanced and the stability is poor.
Back Pedal and Forward Swing Distance

From the perspective of biomechanics and physics, the strength of the back pedal during the walking process of the athlete, and the length of the back pedal distance can determine the effect of the action during the walking. It can be seen that during the high and low speed walking, Kaihua Wang's back pedal distance is relatively larger than that of Toshikazu Yamanishi, but the difference between Kaihua Wang’s left and right foot pedal distance is relatively larger than that of Toshikazu Yamanishi. From low speed to high speeds, the rear pedal distance is reduced relative to that of Toshikazu Yamanishi, which will affect the movement effect during walking. Analyzing the impact of the swinging leg on the ground clearance technology from another angle is also very important. The forward swinging distance of the swinging leg is a very reliable analysis index. It can be seen from the forward swing distance that Kaihua Wang is high. When walking at a low speed, the left and right forward swing distance is greater than that of Toshikazu Yamanishi, but the difference between Kaihua Wang’s left and right leg swing distance is greater than the difference between the left and right leg distance of Toshikazu Yamanishi. It is large, because Kaihua Wang's back kick distance is larger than that of Toshikazu Yamanishi, so when walking at high and low speeds, the forward swing distance of the left and right legs is also larger than that of Toshikazu Yamanishi. Kaihua Wang motion effects to be affected.

Table 3. Statistics of Related Distance Indicators.

| Name         | Front swing distance (m) | Back pedal distance (m) |
|--------------|--------------------------|-------------------------|
|              | high speed left | right | Low speed left | right | high speed left | right | low speed left | right |
| Kaihua Wang  | 0.37                | 0.25  | 0.34          | 0.29  | 0.45            | 0.55  | 0.47          | 0.44  |
| Toshikazu    | 0.19                | 0.24  | 0.23          | 0.27  | 0.39            | 0.45  | 0.42          | 0.40  |
| Yamanishi    |                      |       |               |       |                 |       |               |       |

Flying Distance and Undulating Distance of the Body

The flying distance can reflect the athlete's balance ability during walking. From the data in Table 4, it can be analyzed that Kaihua Wang's left leg emptying distance is 0.24m, the right leg emptying distance is 0.23, and the left leg emptying distance at low speed. It is 0.28m, the distance of right leg clearance is 0.25m, the distance of left leg clearance is 0.24m for Toshikazu Yamanishi Expressway, the distance of right leg clearance is 0.20m, the distance of left leg clearance is 0.17m, and the distance of right leg clearance is 0.19m. This can also reflect on the side that Kaihua Wang's balancing ability is stronger than that of Toshikazu Yamanishi. The difference in the vacant distance of the left and right legs is 0.03m larger than Kaihua Wang when walking at high speed, and the difference between the two is 0.1 when walking at low speed, so Kaihua Wang is slightly larger, so Kaihua Wang has a slight advantage over Toshikazu Yamanishi on the other hand. On the other hand, in the walking race, the referee will judge whether the athlete's technique is fouled mainly by the size of the head in the long-distance prediction process. Ivanici research finds that the head-to-head distance of 4-6cm is most suitable (about 1938 era) [1]. However, in the case of the world’s walking race, the research has been continuously conducted in recent years. It was found that the head undulation distance of excellent athletes is 5-8cm [2]. Kaihua Wang's body undulation distance is 10cm when walking at high speed, and 11cm when walking at low speed. The body undulation distance between Shanxi and high speed is 11cm, and the body undulation distance at low speed is 8cm. Based on this data, it is analyzed that Kaihua Wang is better than Toshikazu Yamanishi on the left and right balance, but Toshikazu Yamanishi is closer to the world-class reference value, so under the same conditions, the referee's chances of Kaihua Wang being sentenced under the naked eye will be larger. Toshikazu Yamanishi has a higher chance of penalty when walking at high speed than Kaihua Wang.
Table 4. Statistical Chart of Distance Indicators.

| Name           | Flying distance (m) | Body undulation distance (m) |
|----------------|---------------------|-----------------------------|
|                | high speed left     | low speed left              |
| Kaihua Wang    | 0.23                | 0.28                        |
| Toshikazu Yamanishi | 0.24         | 0.17                        |
|                | right               | right                       |
| Kaihua Wang    | 0.24                | 0.25                        |
| Toshikazu Yamanishi | 0.20         | 0.19                        |
|                | High speed low speed|                             |
| Kaihua Wang    | 0.10                | 0.11                        |
| Toshikazu Yamanishi | 0.11         | 0.08                        |

Characteristics of Changes in Upper and Lower Limb Angles during Walking

Based on the analysis and interpretation in Table 5, Kaihua Wang's left and right backswing angles are 63.4 degrees during the high-speed walking, and the average backswing angle is 63.4 degrees. The left and right arm angles are 44.3 degrees, and the average size is 44.3 degrees. When walking, the angle of the left and right arms is 58.1 degrees, the angle of the right and left arms is 78.3 degrees, and the average angle of the large and small arms is 64.2 degrees. When walking at low speed, the left rear swing angle is 60 degrees, and the right rear swing angle is 51.7 degrees. The sway angle when walking left is 62.0 degrees, and the sway angle when walking right is 62.9 degrees. The average sway angle is 62.45 degrees, the angle between the large and small arms when leaving is 65.4 degrees, and the sway angle when leaving is right. It is 84.6 degrees, with an average sway angle of 75 degrees. When walking at low speed, the angle of the left and right arms is 63.9 degrees, the angle of the right and left arms is 63.6 degrees, the angle of the left sway is 63.75 degrees, and the angle of the right sway is 62.8 degrees. The swing angle of upper limbs Kaihua Wang has a large swing angle from high speed to low speed, the left and right swing angles are unstable, and Toshikazu Yamanishi is much more stable than Kaihua Wang. The angle between the large and small arms is due to the force of the elbow during the high speed walking of the athlete. The size is determined by the Russian scientific research that the degree of the angle between the two arms is determined by the faster the speed, the greater the angle between the big and small arms. Brian Hanley believes that when the foot is off the ground, the angle between the big and small arms should be about 67 degrees [3]. In data analysis, Kaihua Wang's angle of the big and small arms is smaller than that of Shanxi and the swing amplitude is not. Toshikazu Yamanishi is big, it is necessary to strengthen the amplitude of upper limb swing, and to approach the reference value during high-speed walking.

The angle between the two thighs designed in this paper is determined according to the position of the athlete's big rotor, and then connected to the line between the heel of the swinging leg and the toe of the rear kick leg to determine the index number of the two thigh angle [4]. It can be seen that Kaihua Wang's left angle between the two thighs is 46.9 degrees when walking at high speed, the right angle is 46.3 degrees from both thighs, and the left angle is 44.3 degrees when walking at low speeds. The right angle is 45.2 degrees when leaving the right, and The angle between the left thigh of Toshikazu Yamanishi on the high speed is 41.3 degrees, the angle of the two thighs is 44.9 degrees when the right is left, the angle of the two thighs is 45.6 degrees when the left is low speed, and the angle of the two thighs is 46.2 degrees from the high speed. When walking to a low speed, the angle between Kaihua Wang’s two thighs gradually decreases, and at low speeds, the difference between the angles of the left and right thighs is large, and when Shanxi goes from high speed to low speed, the low speed is greater than the high speed, indicating that in order to pursue the step frequency when walking at high speed Make the hip joint relatively tight, with a small stride. Kaihua Wang's high-speed walking is larger than the angle between the two thighs of Toshikazu Yamanishi, and the difference between the angles of the left and right thighs is smaller than that of Toshikazu Yamanishi. On the one hand, it shows Kaihua Wang's two leg movements. The amplitude is better than Shanxi Large, better hip flexibility, timeliness of action to be big, strong balance about stability, relative to Sealy Hill and in the process of taking physical action more relaxed.
Table 5. Statistics of Swinging Arms and Swinging Legs.

|                          | Boom swing angle | Angle of front and back arms | Angle between legs |
|--------------------------|------------------|------------------------------|-------------------|
|                          | left  | right | average | left  | right | average | left | right | average |
| Kaihua Wang Expressway   | 63.4  | 63.4  | 63.4    | 44.3  | 44.3  | 44.3    | 46.9 | 46.3  | 46.6    |
| Toshikazu Yamanishi Expressway | 62    | 62.9  | 62.45   | 65.4  | 84.6  | 75      | 41.3 | 44.9  | 43.1    |
| Kaihua Wang Low speed    | 60    | 51.7  | 55.9    | 58.1  | 70.3  | 64.2    | 44.3 | 45.2  | 44.8    |
| Toshikazu Yamanishi Low Speed | 62.8  | 53.4  | 58.1    | 63.9  | 63.6  | 63.7    | 45.6 | 46.2  | 45.9    |

Thigh Overlapping Knee Joint Angle and Landing Angle

In this article, the angle of the thigh overlapping knee joint can reflect the level of relaxation of the lower limb during walking. The more relaxed the back swing phase is, the larger the angle of overlapping knee joint is. From Table 6, it can be analyzed that Kaihua Wang's left leg that is walking at high speed and overlaps the knee angle It is 95.6 degrees, the angle of the overlapping knee joint with the right leg off the ground is 92.3 degrees, the average overlapping knee joint angle is 93.95 degrees, the overlapping knee joint angle when walking at a low speed is 98.5, and the overlapping knee joint angle is 98.7 degrees when walking off the right. The average overlapping knee joint angle is 98.6 degrees. When Toshikazu Yamanishi is walking at a high speed, the overlapping knee angle of the left leg is 91.5 degrees, the vertical knee angle of the right leg is 93.8 degrees, and the average overlapping knee angle is 92.65 degrees. The left knee angle is 95.9 degrees, the right knee angle is 95.8 degrees, and the average knee angle is 95.75 degrees. Kaihua Wang's average knee angle when walking at high and low speeds is greater than that of Toshikazu Yamanishi. The situation of downhill Toshikazu Yamanishi will be a bit more serious than Kaihua Wang, but the overlapping knee angles of the two are relatively small. Zong Huajing's research on the world's best walking athletes, it is determined that the overlap angle of the thigh is between 100 degrees and 110 degrees [3, 4]. Therefore, Kaihua Wang and Toshikazu Yamanishi did not reach the corresponding reference index, which may be caused by nervousness during high-speed walking and excessive movement during acceleration. So strengthen the degree of relaxation of the calf after kicking off.

Landing angle analysis and interpretation: Table 6 can be obtained that Kaihua Wang's right foot landing angle is 22.0 degrees, the left foot landing angle is 19.3 degrees, and the average landing angle is 20.65 degrees. When walking at low speed, the left foot landing angle is 22.1, and the right foot landing angle is 19.9. Degrees, the average landing angle is 21 degrees. Toshikazu Yamanishi's right foot landing angle is 22.4 degrees, the left foot landing angle is 23.0 degrees, the average landing angle is 22.7 degrees, when walking at low speed, the left foot landing angle is 22.8, and the right foot landing angle is 24. Degrees, the average landing angle of 23.4 degrees, the foot landing angle of the world's outstanding athletes is about 25 degrees, and the left and right landing angles of Kaihua Wang and Toshikazu Yamanishi did not reach the reference value of 25 degrees [5], and Shanxi Lihe and high and low speed walking angle It is larger than Kaihua Wang's, closer to the reference value of 25 degrees. And during the high-speed walking, Kaihua Wang's left foot landing angle is too small, which means that his left support stage has a large undulation distance, which reduces the stability of walking technology [5].

Conclusions and Recommendations

Conclusions

Kaihua Wang has a larger stride when compared with Toshikazu Yamanishi at high and low speeds, which is closer to the stride length of the world's outstanding athletes. However, Kaihua Wang has uneven steps on the left and right, and the step frequency is slightly disadvantaged.
Table 6. Statistics of Overlap of Two Thighs and Landing Angle of Two Feet.

|                | Overlap of two thighs | Landing angle of both feet |
|----------------|-----------------------|---------------------------|
|                | left      | right     | average | left   | right   | average|
| Kaihua Wang    | 95.6      | 92.3      | 93.95   | 19.3   | 22.0    | 20.65  |
| Expressway     |           |           |         |        |         |        |
| Toshikazu      | 91.5      | 93.8      | 92.65   | 23.0   | 22.4    | 22.7   |
| Yamanishi      |           |           |         |        |         |        |
| Kaihua Wang    | 98.5      | 98.7      | 98.6    | 22.1   | 19.9    | 21     |
| low speed      |           |           |         |        |         |        |
| Toshikazu      | 95.9      | 95.6      | 95.75   | 22.8   | 24      | 23.4   |
| Yamanishi      |           |           |         |        |         |        |

From the ground-off technology, although Kaihua Wang's distance between the rear kick and the front swing is greater than that of Toshikazu Yamanishi, the force of the left and right leg kicks and front swings is uneven, which affects the movement effect. At the same time, Toshikazu Yamanishi needs to increase the distance between the rear kick and front swing.

It can be seen from the flying distance and the body undulation distance that Kaihua Wang is stronger than Shanxi Lihe and the balance ability, but the body undulation distance is larger than the reference index of the body undulation distance of high-level athletes in the world. Shanxi Lihe and the body undulation distance when walking at high speed are larger.

In the change of the angles of various joints, Kaihua Wang's upper limbs swing less when walking at high and low speeds, and the left and right are not balanced, but the lower limbs are larger than Shanxi and the swings are larger.

Both of them did not reach the standard reference value from the angle of thigh overlap. Shanxi and Houyi phenomenon were larger than Kaihua Wang. When landing, Kaihua Wang had a small landing angle on the left side and a large undulation distance on the head when supporting on the left side.

**Recommendations**

Kaihua Wang needs to improve the balance of left and right cadence and the balance of left and right forward swing and back kick distance to enhance the effect of movement. Further reduce the left and right vacant undulation deviation, reduce the undulation distance of the body, and relax the lower limbs during walking. Increasing the overlapping angle of the two thighs, and increasing the amplitude of the upper limb swing arm during training, especially the angle between the large and small arms during the swing process, improve the timeliness and standardization of the overall technology.

Toshikazu Yamanishi should increase the stride length and step length during walking, strengthen the distance of the rear pedal, and increase the forward swing distance. Reduce the vacant distance and the body undulation distance when walking at high speed. The lower limb should be raised on the lower limb. The degree of relaxation and increase the swing amplitude.

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