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Article

Research on innovation of backbasket throwing embroidery ball supported by biomechanics and information technology

Hua Xiao[1], Shijun Xu[2,*], Cong Zeng[3,*], Ling Li[4], Xiaochen Wang[5]

[1] College of Automotive Engineering, Liuzhou Institute of Technology, Liuzhou 545616, China
[2] Physical Education College, Guangxi University of Science and Technology, Liuzhou 545006, China
[3] Sports Department, Liuzhou Institute of Technology, Liuzhou 545616, China
[4] School of Arts and Sciences, Nanning College of Technology, Nanning 530100, China
[5] College of Sports and Health, Yulin Normal University, Yulin 537000, China
*** Corresponding authors:** Shijun Xu, xushijun2008@126.com; Cong Zeng, zengcong2023@163.com

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Abstract: Objective: This study aims to inherit the national sports culture of throwing embroidered balls, combine technological innovation with the application of technological information, improve the competitive level and competition management level of the backbasket throwing embroidered ball. **Method:** Utilizing methods such as literature review and mathematical statistics to elucidate the evolutionary history of embroidered ball culture, analyze the development process of the backbasket throwing embroidery ball sport and throwing technology using biomechanics; Research innovative throwing techniques and tactical applications through comparative analysis of competition results. **Result:** There are problems with the lack of theoretical throwing techniques, imperfect competition rules, and inconsistent embroidery balls in competition. The training results of the short fast low ($\alpha \leq 30°$) throwing method are outstanding, but insufficient stability leads to easy mistakes in competition, it requires athletes with good psychological qualities; The training performance of the long slow high ($\alpha > 30°$) throwing method is poor, but it has good stability and is easy to exert competitive ability in competitions. **Conclusion:** Emphasize the inheritance of ethnic sports culture and enhance social participation interest. The mixed throwing method, with short fast low throwing as the main method and long slow high throwing as the auxiliary method, can effectively improve the level of competition. Utilizing modern elements such as unmanned aerial vehicles and information technology management to improve the level of referees and promote the sustainable development of ethnic sports.

Keywords: backbasket throwing embroidery ball; throwing technology; speed; angle; information technology; competition rules

1. Introduction

Embroidery balls are one of the most representative cultural symbols of the Zhuang nationality, and the culture of throwing embroidered ball has a history of over two thousand years. In the early 1980s, the embroidery ball throwing activity was excavated and organized, and developed into a popular embroidery ball throwing sport, which was quickly promoted. At present, the sport of throwing embroidered balls has become a competition event in various major competitions in Guangxi, with two major events set up: high pole throwing embroidered balls and backbasket throwing embroidered balls, which have high competitive sports value and national cultural value. Among them, the development of basket throwing embroidery balls lags behind that of high pole throwing embroidery balls, and is mostly carried out in the fields of social sports and school sports, with leisure and entertainment as the main

organizational form. The sport of throwing embroidered ball in the backbasket started relatively late, and there is little research on related techniques and tactics.

The sport of backbasket throwing embroidery ball has problems such as inconsistent use of balls, low competitive level, and incomplete competition rules, which hinder the promotion and high-level development of the sport. These issues be effectively addressed through our comparative experimental study on projection methods. This study aims to enhance interest in participating in sports by tracing the origins of ethnic cultures from multiple perspectives. Using human biomechanics to explain the optimal speed and angle for throwing embroidered ball, Innovate throwing techniques and improve competitive skills through comparative analysis of training and competition results. The publication of this paper result in a significant enhancement of the overall performance of this sport by enhancing projection techniques and referee skills. By unifying the equipment of the competition, utilizing drone aerial photography and information technology support, improving the level of referees, perfecting competition rules, and providing an effective path to promote the standardized and international development of the backbasket throwing embroidery ball sport, and innovating and inheriting excellent national sports culture.

2. Literature review

2.1. The past and present lives of embroidered ball

There are two main theories about the origin of throwing embroidered balls: the theory of "weapons" used for hunting and combat, and "marriage tools" used for communication between young men and women [1,2]. The folk embroidery ball throwing activity originated from the life and production labor of ancient ethnic minorities, reflecting the social needs and traditional ethnic emotions of that time [3,4]. The process of its emergence and evolution is accompanied by people's adaptation and transformation of the natural environment, as well as the progress of social civilization and the process of social change. Many scholars mainly explore the "Feituo (a "flying bronze block" thrown with a rope tied to its tail), cloth thorns, embroidered cages, embroidered balls", as well as "hunting and combat, entertainment and exchange, throwing embroidered balls for blind dates, and throwing embroidered balls sports" [5,6].

2.2. Multi perspective tracing of the culture of throwing embroidered balls

The throwing of embroidered balls by the Han ethnic group originated from the "throwing melons" marriage custom of "women spreading love through flowers and plants, and men reporting jade and fixing love", as well as the ancient custom of "throwing plums" in the pre Qin marriage custom [7]. The Zhuang's throwing embroidered ball is a rope tied throwing weapon used for hunting and combat (see **Figure 1**). It was first recorded to have appeared on the "Feituo" painted on the Huashan mural in Ningming County, Guangxi over two thousand years ago [8].

Figure 1. Huashan rock paintings in Ningming County, Chongzuo City, Guangxi.

During the Tang Dynasty, people made bags of silk and embroidered some auspicious patterns by hand, known as "cloth thorns". Their functions gradually evolved from weapon to entertainment and communication [9]. In the Song Dynasty's "Xi Man Cong Xiao", it is recorded that during the Chinese New Year's Day, men and women in rural areas were divided into two groups, taking five-colored knots as the ball and throw and caught them with each other, known as "Feituo" [10]. In "Lingwai Daida," it is recorded that on the Shangsi Festival, men and women taking five-colored knots that is called Feituo, and throwing it while singing. If the man and woman like each other, the woman will ac**-**cept the Feituo and they will get married [11]. After the Song and Yuan dynasties, the custom of throwing embroidered balls gradually developing into a form of social entertainment for young men and women and a traditional ethnic sports activity. Embroidered Ball carries the cultural spirit of the Zhuang people in different eras, interpreting the inheritance of national sports culture [12]. These various opinions on the origin of throwing embroidered balls reflects the national and diverse nature of traditional Chinese culture.

2.3. The rise of throwing embroidered balls

Rules for the competition

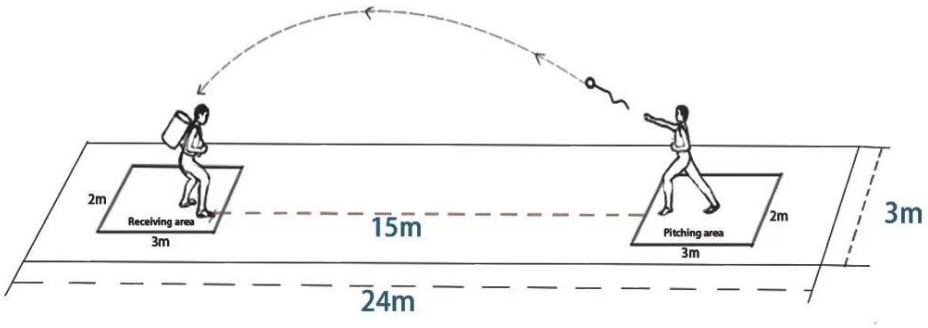

Figure 2. Rules of throwing backbasket embroidery ball.

Athletes shall throw embroidered balls into the backbasket of their team members within the prescribed time. The one who throws more will win, and if the number of goals is the same, the one who takes less time will win. Venue: Set up a flat ground with a length of 15 m and a width of 2 m, with one end separated by 15 m as the throwing limit line and the other end as the receiving limit line. Outside the limit line, there are rectangular throwing and receiving areas with a length of 3 m and a width of 2 m respectively (see **Figure 2**). There are 5 team members, 4 pitchers, and 1 catcher.

There will be only a team game, with each group lasting 3 min. The game begins: The pitcher must stand in the pitching area one by one, with 6 balls per person. Only 1 ball can be thrown in order to the catcher at a time; The receiver stands in the receiving area and receives the ball with a basket on their back.

Since the establishment of the Guangxi Zhuang Autonomous Region in 1958, ethnic sports workers excavated and organized the throwing and receiving of"embroidered balls"and "throwing colored balls," later known as "throwing embroidered balls." In the early 1980s, they excavated and organized the"throwing embroidered balls"sports event, establishing developed relevant competition rules and referee methods. In 1986, they officially established the high-pole throwing embroidered ball as a competition event in Guangxi [13]. At the Fourth National Ethnic Minority Traditional Sports Games in 1991, the Guangxi Embroidered Team presented this traditional Zhuang event for the first time at a national level event [14]. In recent years, the sport of throwing embroidered balls has developed rapidly. In the 11th Guangxi Student Games in 2016, there were 42 participating teams, and in the 13th Guangxi Student Games in 2023, this number increased to 61. The teams were categorized into four groups: middle school, vocational college, regular undergraduate, and professional groups. The development of backbasket throwing embroidery ball is relatively lagging behind, with only two events set up: men's team competition and women's team competition. It was not until the 13th Student Games in 2023 that it officially became a university competition.

According to the performance evaluation rules, the winner of a throwing embroidered ball is the one with the highest number of hits per unit time. According to the classification of the dominant factors of competitive ability, it belongs to the accuracy category of technical and psychological ability. Classified by action structure [15], it belongs to a fixed combination of multiple action structures and has evident cyclical characteristics. According to the competition rules, to win, it is necessary to complete more shots per unit time and improve the hit rate. This is a sports event that tests the coordination of athletes' psychology, skills, and physical fitness.

3. Methodology

3.1. Research subjects

The shooting techniques of backbasket throwing embroidery ball. Compare and analyze the results of the male and female teams of Liuzhou Institute of Technology in two different throwing methods, and determine their performance in training and competition.

3.2. Research methods

Research Design: Analyze the results of the top 5 backbasket throwing embroidery ball competitions, determine the development trend of competitive level (see **Table 1**), and then study the throwing methods under the combination of circular techniques and throwing angles. First, using a short rope as the radius to quickly wrap around, the low angle ($\alpha \leq 30°$) throwing method, abbreviated as the short fast low throwing method (A throwing method), participated in the 15th Guangxi National

Traditional Games; Then, using a medium long rope as the radius for a slowly wrap around, the high angle ($\alpha > 30°$) throwing method, abbreviated as the Long Slow High throwing Method (B throwing method), participated in the 13th Guangxi Student Games. Randomly select the test results of two throwing methods in 30 training sessions in the month before the competition for comparative analysis. Minimize the influence of psychological factors and focus on research on throwing methods.

Table 1. Analysis of the results of the men's team in the 13th Guangxi student games.

Placed	Team name	Throwing method	Hits/Shots	Time (s)	Hit rate (%)
1	Liuzhou Institute of Technology	A	24/24	45.39	100
2	Guangxi Vocational Normal University	A	24/24	46.48	100
3	Guilin University of Electronic Science and Technology	A	24/24	48.27	100
4	Guilin Medical College	B	24/24	56.62	100
5	Guilin University of Technology	B	21/24	59.27	87.5

Table 2. *T*-test of training results for two throwing methods in men's teams.

Category	Time (s)	Hits (*n*)	Hit rate (%)
The 15th Ethnic Minority Games (throwing method A)	40.29 ± 1.24	23.20 ± 0.10	96.80 ± 3.90
The 13th Student Games (throwing method B)	41.06 ± 1.58	23.70 ± 0.53	98.75 ± 2.23
Difference	−0.77	−0.50	−1.95
t	−2.097	−2.421	−2.372
p	0.040*	0.020*	0.022*

* $p < 0.05$ ** $p < 0.01$.

Table 3. *T*-test of training results for two throwing methods in women's teams.

Category	Time (s)	Hits (*n*)	Hit rate (%)
The 15th Ethnic Minority Games (throwing method A)	37.83 ± 1.40	23.07 ± 1.05	96.11 ± 4.37
The 13th Student Games (throwing method B)	40.73 ± 2.12	23.67 ± 0.55	98.61 ± 2.28
Difference	−2.90	−0.60	−2.50
t	−6.248	−2.780	−2.780
p	0.000**	0.008**	0.008**

* $p < 0.05$ ** $p < 0.01$.

Mathematical statistics method: Collect the results of two teams in the training and competition of backbasket throwing embroidered ball at the 15th Guangxi Ethnic Games and the 13th Student Games (see **Tables 2** and **3**). Based on the winning factor structure of the event group theory, collect data on training and competition time, number of hits, and hit rate, etc. Using t-test to study the differences in time, number of goals scored, and hit rate of the two throwing methods A and B during the training

process. Compare the mean ± standard deviation ($\overline{X}$ ± s) of each indicator in the data and compare the significant differences between groups. Analyze the impact of factors such as throwing, tactics, and competition rules on competition results.

3.3. Research process and strategies diagram

According to the research design, the following issues were identified: The technique of backbasket throwing embroidery balls is lacking, the level of competition is low, and the competition rules are not perfect. According to the trend of modern development of ethnic sports, design two ways to achieve research goals: improving throwing technology and information management (see **Figure 3**). Innovate throwing methods through comparative analysis of competition results. The application of UAV photography to monitor the hit of the ball improves the referee's level, and the use of information technology management enhances the level of competition information management. The goal is to innovate throwing techniques, improve competitive level and information management of competitions.

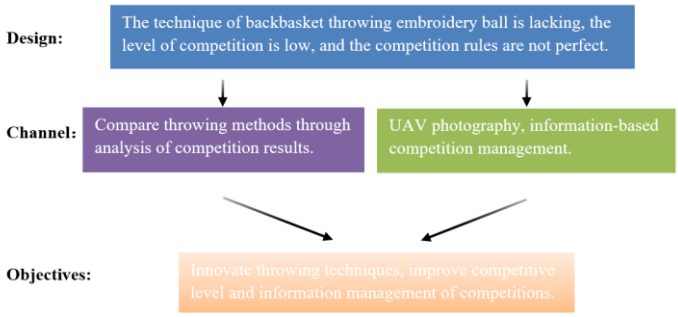

Figure 3. The research process and methodology strategy.

4. Result analysis

4.1. Analysis of competitive level development

Taking the recent competition as an example, the top 4 teams have a 100% hit rate, and there are 3 teams with a game time of less than 50 s. The competition level is developing towards a fast and accurate direction. However, teams with lower competitive levels use the long slow high throwing method to seek stability, resulting in a significant gap in performance compared to the top three, significantly prolonged time, and a significant decrease in hit rate (see **Table 1**).

4.2. Comparative analysis of two throwing methods in pre match training

Men's team: From **Table 2**, it can be seen that there are significant differences ($p < 0.05$) in terms of time, number of goals scored, and hit rate between the two throwing methods. The specific analysis is as follows: Firstly, in terms of time, the difference in the average value is −0.77. During training, throwing method A (40.29 s) took less time than throwing method B (41.06 s); There is a significance level of 0.05 ($t = -2.097$, $p = 0.040$). Secondly, in terms of the number of goals scored, the difference is −0.50, and the number of goals scored by the throwing method A (23.20) is less than that by the throwing method (23.70); There was a significance level of 0.05 ($t = -2.421$, $p =$

0.020). Thirdly, in terms of hit rate, the difference was −1.95, and the throwing method A (96.80) was lower than the throwing method B (98.75); The score showed a significance level of 0.05 ($t = -2.372$, $p = 0.022$). The number of goals and hit rate of throwing method B were higher than those of throwing method A, but the duration was slightly longer. From $0.01 < p < 0.05$, it can be inferred that there is a difference between the two projection methods used by boys.

Women's team: Use t-test to analyze the differences in performance between two throwing methods during training (see **Table 3**). There are significant differences ($p < 0.05$) in terms of time, hits, and hit rate between the two throwing methods. Specifically, in terms of time, the difference between the average values is −2.90, and throwing method A (37.83 s) takes a shorter time than throwing method B (40.73 seconds); There was a significance level of 0.01 ($t = -6.248$, $p = 0.000$). Secondly, in terms of the hits, the difference was −0.60, and the hits by the throwing method A (23.07) was less than that by the throwing method B (23.67); There was a significance level of 0.05 ($t = -2.780$, $p = 0.008$). Thirdly, in terms of hit rate, the difference was −2.50, and throwing method A (96.11) was lower than throwing method B (98.61); There is a significant difference at the 0.01 level ($t = -2.780$, $p = 0.008$). The number of hits and hit rate of throwing method B are higher than those of throwing method A, but the time required increases. From $p < 0.01$, it can be seen that there is a significant difference between the two projection methods used by girls.

The men's team of the 15th Ethnic Minority Games (see **Table 4**): The competition took 1.79 s longer than the training average, with 1.2 fewer hits and a 5.14% decrease in hit rate, ranking ninth. **Figure 4** shows a sudden decrease in hit rate. Women's team: The competition took 6.60 s longer than training, with a slightly less hits of 0.07 and a decrease in hit rate of 0.28%, ranking second. From the hit rate curve, it can be seen that compared to training, the athletic level of male players is abnormal, while the athletic level of female players is relatively stable.

The men's team of the 13th Student Games: The competition took 4.33 s longer than training, with an increase of 0.3 more hits (all hits) and a 1.25% (100%) increase in hit rate, winning the championship. Women's team: The competition took 7.21 s longer than the training average, with a decrease of 0.67 hits and a decrease of 2.78% in hit rate, ranking third. From the hit rate curve, it can be seen that compared to training, male players have shown exceptional athletic abilities, while female players have shown a decline in their athletic abilities, resulting in less than ideal performance.

Table 4. Comparison of training (mean) and competition results.

Competition (method)	Gender (ranking)	Category	Time(s)	Hits(n)	Hit rate(%)
The 15th Ethnic Minority Games (throwing method A)	Male (9th)	Train	40.29	23.20	96.80
		Competition	42.08	22	91.66
	Female (Second)	Train	37.83	23.07	96.11
		Competition	44.43	23	95.83
The 13th Student Games (throwing method B)	Male (First)	Train	41.06	23.70	98.75
		Competition	45.39	24	100
	Female (Third)	Train	40.73	23.67	98.61
		Competition	47.94	23	95.83

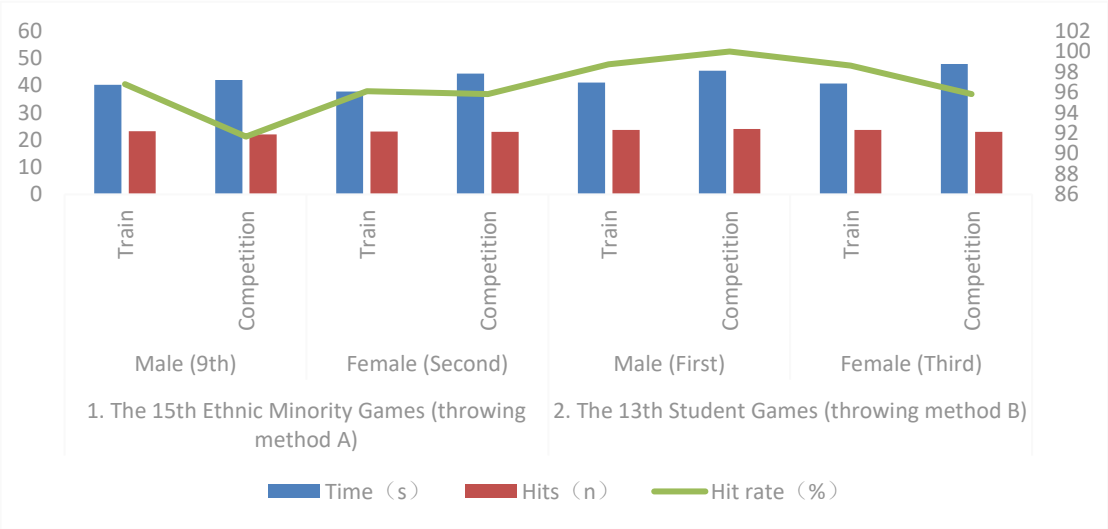

Figure 4. Comparison of training (Mean) and competition results of each team.

4.3. Theoretical analysis of throwing technology

Using human biomechanics to explain the optimal speed and angle of movement skills. Biomechanics is the study of why and how a living thing moves through a certain environment in order to complete a task [16]. In the study of table tennis, creating a musculoskeletal model to investigate the muscle forces, joint kinematic, and joint kinetic characteristics of the footwork during topspin forehand stroke [17]. Introduce information technology into sports training research and use specialized digital training to improve double poling technique for para seated cross-country skiing athletes [18]. These studies provide feasible references for the application of biomechanics and information technology in the study of ethnic sports such as throwing embroidered balls.

4.3.1. Technique of wrap around

The first technique of holding the ball is to pull the rope and throw it directly up (see **Figure 5**), which is mostly used for beginner teaching. The actions are simple and easy to learn, and the casting is fast, but the stability is poor, making it unsuitable for competition. The second is throw technique of wrap around (see **Figure 6**), which allows for a greater initial velocity of the shot after a looping around, which is beneficial for mastering direction and strength, but takes a longer time to make the shot. During the training process, with the introduction of the Long Slow High Throwing Method (throwing method B), a dynamic pattern is formed. In order to achieve victory, the innovative development of the Short Fast Low Throwing Method (throwing method A) shortens the shooting time and improves athletic performance. However, the training difficulty of the A-throwing method is relatively high, and it is necessary to continuously enhance the control ability of the hand through training, so as to form new movement pattern for the angle and speed of the hand, and improve stability.

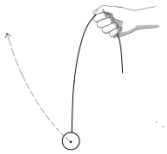

Figure 5. Direct up throw technique.

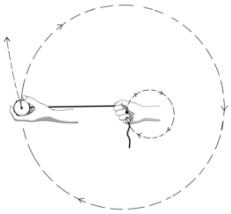

Figure 6. Throw technique of wrap around.

The development of the sport of throwing embroidered balls in the backbasket was relatively lagging behind, and it did not become an official competition until the early 21st century. There is relatively little theoretical research on the core throwing technique, and the content mainly focuses on the guidance of the action structure and throwing requirements in school physical education teaching, without mentioning the details of throwing techniques and methods [19,20]. Professional technical research from the perspective of physical mechanics is even rarer.

4.3.2. Analysis of the best situation for the ball entering the basket

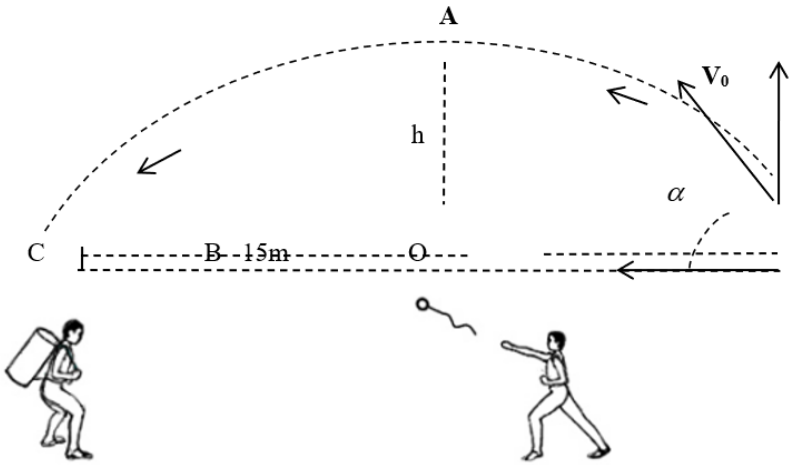

Figure 7. Backbasket embroidery ball throwing technique.

According to the referee rules of the recent Guangxi 2022 Ethnic Minority Games and the 2023 Student Games, the last ball thrown by an athlete falls into the basket as the end time of the game. Therefore, as shown in **Figure 7**, the height of vertex A of the ball's flight curve OAC should be controlled at a lower position, and the ball should stay in the air for a short time, which is conducive to creating excellent results. Based on years of training and competition experience, the shooting angle is controlled within 30°, and the pitcher's movements are relatively easy. The receiver can better judge the flight trajectory of the ball. At this time, the parabolic trajectory of the

embroidered ball is as follows: horizontal distance OC = 15 m, assuming that the time it takes for the ball to reach the highest point A from the shooting is t, and the horizontal displacement time is consistent with the up and down times, then:

∵The time required for vertical displacement AB = h is the same as the time required for horizontal displacement OB, and the horizontal distance OB = 15/2 = 7.5 m

∴OB = $v_0t = v_0\cos\alpha t$, $t = OB/v_0\cos\alpha = 7.5/v_0\cos\alpha$, then $v_0\cos\alpha = 7.5/t$ (1)

Vertical displacement: $h = v_0\sin\alpha t - 1/2gt^2$, obtain: $v_0\sin\alpha = (h + 1/2gt^2)/t$ (2)

∵Vertical displacement: $h = 1/2\ gt^2$, obtain: $t = \sqrt{2h/g}$ (3)

∴Combining (1), (2), and (3): $v_0\sin\alpha / v_0\cos\alpha = \tan\alpha = gt/7.5/t = gt^2/7.5$

Substitute $\alpha = 30°$ into the above equation and obtain: $t = \sqrt{7.5/g} \approx 0.87$ s (4)

Combining (3) and (4) yields: $\sqrt{7.5/g} = \sqrt{2h/g}$,and the height at this point is: $h = 7.5/2 = 3.75$ m

∵Vertical speed of the shot is: $v_0\sin\alpha = gt$, then $v_0 = gt/\sin\alpha = 2gt = 2g\sqrt{2h/g}$ (5)

Calculate the current shooting speed: $v_0 = 2g\sqrt{2h/g} = \sqrt{8hg} \approx 17.3$ m/s

From (5) $v_0\sin\alpha = gt = g\sqrt{2h/g} = \sqrt{2hg}$ it can be seen that when time t is fixed, $t = v_0\sin\alpha /g$, then v_0 and $\sin\alpha$are inversely proportional. The faster the shooting speed, the lower the shooting angle. When the horizontal distance and time remain constant, $7.5 = v_0\cos\alpha t$, and v_0 and $\cos\alpha$are inversely proportional. The larger the angle of release, the greater the speed. When the shooting speed is fixed, $v_0 = \sin\alpha /g \times t$, then t is directly proportional to $\sin\alpha$, and the larger the shooting angle, the longer the duration. Controlling the throwing angle during practice is easier than controlling the throwing speed, therefore, controlling the speed while controlling the angle can more effectively improve the hit rate. The faster the initial speed, the lower the height, and the less time it takes.

4.4. Rules and disputes of the backbasket embroidery ball throwing competition

4.4.1. Match ball

Figure 8. Sandbag ball.

Figure 9. Traditional embroidery ball.

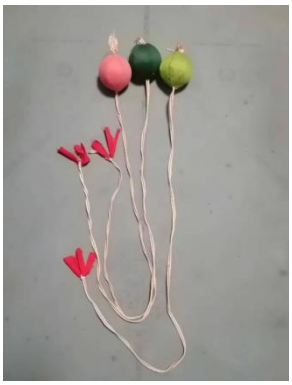

Figure 10. Rubber balloon.

The use of balls in matches is highly controversial, with almost every game using a different ball. Embroidery throwing is a sport that requires high precision in hand movements. At present, there are mainly two types of balls. One is a sandbag ball filled with fine sand directly from colored cloth (see **Figure 8**), which has lost the characteristics of traditional embroidered balls (see **Figure 9**). Although the throwing feel is poor, there is no rebound after entering the basket, and receiving the ball is relatively stable; The second is to fill the inner rubber bladder with fine sand, and the ball wrapped in colored cloth on the outside has a good throwing feel, but it is easy to bounce out when entering the basket (see **Figure 10**). The shape, mass, and elasticity of the ball, as well as the thickness of the tail rope, directly affect the athlete's hand feel and athletic performance. The competition embroidered ball is provided by the conference and has multiple product sources, which results in the inability to connect and unify the training ball and the competition ball. Many teams have their results affected due to not using the competition ball for training, while the participating teams who have been using the competition ball have a clear advantage.

4.4.2. Referees

The main controversies in the current competition rules are: firstly, regarding the pitcher: (1) placing the ball in the pitching area. Some teams place 24 balls and their players pitch one by one; Some teams only place a portion of the ball, and when player 1 throws the ball, the players from behind place the ball one by one on the side. The rules are not clearly defined, but the impact on grades is still significant. (2) The connection between pitchers. After a pitcher finishes throwing, when can the next pitcher enter the pitching area to pick up and pitch the ball? Will the game end with

the last shot or with the ball in the basket? The second aspect is the receiver: (1) When receiving the ball, the basket cannot be detached from the back of the body. Has the basket and back separated when jumping to catch the ball been penalized? (2) The penalty for the ball bouncing into the basket. If the ball touches the shoulder or head first during flight and then enters the basket, is it a foul? The third is to step on the line. There is no evidence left during manual judgment, the dispute cannot be resolved. With the increasing number of disputes in traditional referees, it is necessary to improve the level of referees by integrating technological information.

5. Discussion

5.1. Exploration of integrating technological information into ethnic sports

Ethnic sports mainly originated from the daily life and production labor of ancient ancestors [21,22]. In order to become a formal competition event "going out of rural", modern elements must be integrated, and in practice, the application of modern technological information is often overlooked [23]. Improving the level of competition organization and management is one of the most effective ways to develop ethnic sports, as it is a concentrated reflection of teaching and training, social sports, and the integration and utilization of social resources [24]. Integrating modern technological information elements into the development of ethnic sports has broad prospects, becoming a new driving force for promoting the development of ethnic sports organization and management, and bringing new vitality to ethnic sports.

5.2. Empowering the development of ethnic sports with technological information

5.2.1. Technical and tactical combination

Innovate throwing methods to improve competitive level. According to the comparison of training and competition results between the male and female teams in two consecutive sports games, it is found that there is an optimized combination between the throwing method and sports performance of high-level sports teams. The men's team adopted an innovative short fast low A throwing method for training at the 15th Ethnic Minority Games, achieving first-class results, but their competition results were poor. Two players lost one goal each during the competition due to psychological factors affecting their use of the A-throwing method. The women's team also reached a first-class level in training, and the competition was also affected by the environment. They slowed down the pace (6.6 s more than the training average) in exchange for stability and won second place, but it took the least time among all teams. Among them, the women's team awarded a penalty of one step on the line in the absence of sufficient evidence, and the dispute was fruitless. After the rematch, they came in second place. In the 13th Student Games, two members of the male team changed to using the long slow high throwing method (B-throwing method) to enhance stability. This method lengthens the rope, increases the radius of the loop, reduces angular velocity, reduces the tension of the motor nerves, and is beneficial for maintaining stability in tense environments. While the other two continued to use the

A-throwing method that suits them. This method shortens the guiding rope, reduces the radius of the loop, increases angular velocity, and thus improves the throwing speed to achieve excellent results. However, increasing the demand for motor nerve control over muscles is not conducive to maintaining stability in tense environments. During the competition, various interferences were effectively eliminated, resulting in stable performance and winning the championship. The women's team also had two players with poor psychological qualities who chose to use the B-throwing method, slowed down the pace to maintain stability, and ultimately lost one goal to win third place. The innovative A-throwing method achieved top-notch results in training, but the training difficulty was high and it was suitable for team members with good psychological qualities. On the other hand, although the B-throwing method took longer, it had better stability and was suitable for team members with weaker psychological qualities. In training and competition, team members should choose the appropriate throwing method based on their self-awareness of competitive ability.

5.2.2. Empowering competitive ability through information technology

The speed of throwing embroidered balls, circling, projecting, and flying in the air is too fast, making it difficult for athletes to form a fixed pattern of movements composed of factors such as angle and speed. With the help of modern technology and information technology resources, the problem of technical action analysis can be effectively solved. In some sports with high popularity and promotion, the application of information technology in technical action research has become very common, while ethnic sports have seriously lagged behind. Computer vision-based motion capture technologies remains the gold standard in biomechanical analysis and continues to dominate sports research applications; It plays a crucial role in optimizing athletes' skills, techniques, and strategies by providing detailed feedback on motion data [25]. For example, motion capture technology accurately captures the movements of students shooting on their shoulder with one hand, and provides targeted exercises to help students improve their shooting skills through timely feedback on motion information [26]. A digital human model was constructed using virtual reality (VR) technology to simulate sports training, improve the quality of data capture, and enhance training effectiveness by providing detailed feedback on motion data [27]. This provides a development direction for future research on ethnic sports techniques and movements. Learn from the training methods of other sports, and actively guide the integration of modern information technology into ethnic sports training and competition practices based on the actual situation at the grassroots level. Using mobile phones to capture the throwing process from different angles (information can be imported into the computer), team members can continuously improve their throwing techniques based on the image analysis of photos and videos, form scientific action patterns, and enhance their competitive level [28].

5.2.3. Embroidery balls for competition

Embroidery ball throwing is a unique traditional ethnic sports event in Zhuang Township. Embroidery ball is a cultural symbol of the Zhuang ethnic group, a realistic carrier of Zhuang cultural genes and national spirit, carrying the customs, emotions, beliefs and other connotations of the Zhuang ethnic group [29]. Therefore, ethnic sports have a natural advantage in ideological and political education, and

participating can cultivate students' patriotism and national sentiment. The 14th and 15th Guangxi People's Games both used the abstract form of hydrangea as the mascot and the creative form of the emblem, and demonstrated the national style of Zhuang Autonomous Region to the world through the Internet [30]. Inheriting ethnic culture is not simply about retro, but about constantly integrating modern elements for innovative development, protecting and promoting traditional excellent culture, and continuing cultural genes [31]. As a sports equipment, sandbags, although meeting the needs of sports competitions, ignore the theme of ethnic cultural inheritance, which is a major failure in sports equipment innovation. It is necessary to preserve ethnic cultural elements.

5.2.4. Empowering competition judges with information management

Applying technology and information technology to competition management, improving referee skills, and resolving disputes are effective measures to promote the development of national sports to a higher level. For example, many aspects of a project manager's work could be managed by machines that utilize AI/ML (artificial intelligence/machine learning) approaches to address nonroutine and predictive tasks [32]. Adapting 3S (scheme, system, and service) model of P2M Framework for Innovation Program Management Through a Lean-Agile Approach [33]. Innovatively applying the inspiration of these information technology management concepts to the management of ethnic sports competitions, to compensate for the shortcomings of traditional manual operations.

As shown in **Figure 11**, using drones to take aerial photos of the receiving area, the information is synchronously transmitted to the backend computer for real-time monitoring, assisting in on-site judgment; Record the activities of the catcher in the receiving area, archive and store information, provide strong evidence for post match disputes and later resource management, and provide technological information support for the standardized development of embroidery throwing competitions [34]. The referee only needs two people to stand diagonally on the front and back control lines of the receiving area, with a line of sight in a "∟" shape with the receiving area. If the catcher steps on the line, a red card can be raised. If there is a dispute, it can be checked through drone video surveillance. By using video playback, pause and other functions, assist the referee in checking whether the athlete has stepped on the line. The application of technological information has saved human resources and improved the level of referees. Meanwhile, by capturing the process of pitching and receiving from multiple angles, it helps to clearly judge and study the trajectory of the ball flying in the air, providing information support for improving the level of competition (see **Figure 12**).

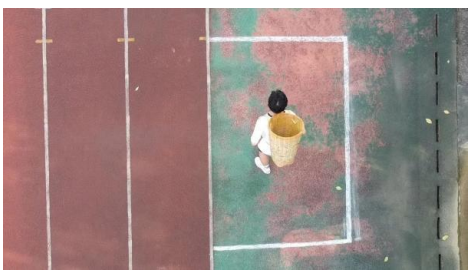

Figure 11. Drone overlooking receiving area.

Figure 12. Throwing methods from different angles.

The development of information technology in ethnic sports management requires decision-makers to have innovative concepts, innovative technologies, and innovative management models, supported by innovative elements such as team operation training for information operation, in order to avoid innovation risks. Digital leadership is a key driver, leading to digital agility. The need for organizations to develop digital leadership while fostering knowledge integration and inter-team coordination [35]. Leverage technology to address recipient's ACAP (recipient's absorptive capacity) will be beneficial for the development of new technologies, especially in electronic learning and customized teaching methods [36]. Security control measures for risks in the era of big data, to strengthen the enterprise's information management innovation and implement the application of data security technology [37]. These concepts, technologies, learning methods, and management models of information management provide inspiration for the innovative development of ethnic sports.

6. Conclusion

The results of the backbasket embroidery ball competition are developing towards a fast, accurate, and stable direction. The high-level sports team training competition mainly adopts the short fast low throwing method, supplemented by the long slow high throwing method, which is a hybrid throwing method. The catcher can receive the ball more calmly and create excellent results. With the help of UAV, the Internet and other scientific and technological information means to assist the referee work, improve the level of referee, reduce disputes, and promote the standardized development of national sports. Utilizing information resources such as shooting and videos to assist in technological research, improving competitive level, promoting the development of national sports to a higher level, and leveraging the powerful driving role of intelligent sports technology. Embroidery balls have gradually become an important cultural symbol of Zhuang Township, and the use of balls in competitions should take into account the inheritance of ethnic cultural genes and the practicality of competitions. The ball is provided by the event organizer and the specifications and procurement channels are announced to the public in advance to provide support for training, and ensure fairness and consistency in competitions. By tracing history and promoting traditional ethnic culture, we aim to enhance people's enthusiasm for participation. Consolidate the foundation of ethnic sports culture and give full play to the unique function of ideological and political education in ethnic sports. Technological information empowers the development of ethnic sports to lead the

future direction, promotes the popularization and promotion of excellent ethnic sports, enters the international stage, and innovatively inherits ethnic sports culture.

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