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Shot throwing technique to performance influence T test based on mathematical statistics

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ABSTRACT

The paper more deeply understands spinning technique application in shot throwing by experiment and data handling. By analyzing, it finds spinning shot putting technique relative conforms to shot movement basic principle and rules. Its lengthening on apparatus accelerated speed distance, motions continuity and fluency, full of rhythm, enlarging on apparatus achieved prior speed and other techniques show that it is current relative advanced shot throwing technique. Spinning technique requires athletes more coordinate and sensitive, but it doesn't have high requirement of athletes' height and weight as well as other indicators, according to Chinese athletes their own features, strength features and better flexibility, coordination and sense of balance, it carries out comparative research on back sliding type and spinning type by data analysis.

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KEYWORDS

Spinning technique;
Shot throwing;
Flight spinning;
Data analysis;
T test.

INTRODUCTION

At present, athletes applied spinning shot putting technique in the world, has constantly created excellent performance and new world records. People that use the technique has also become more and more, it shows spinning shot putting technique scientificity and superiority, in technique, it quite effectively lengthen shot movement trajectory and final exertion working distance, improves muscle fully exertion physiological application conditions, is more beneficial to muscle strength exert, and increases shot release speed.

Chinese athletes shot relative special quality has already got closer to that of foreign applied spinning shot putting technique athletes, they are relative good in standing long jump, triple jump aspects and so on, which

reflects Chinese shot putters' flexibility. Cause of performance larger gap is that adopted technical means are different. Chinese present taught shot putting technique is back sliding shot putting technique, it hasn't yet carried out effective trial promotion on spinning shot putting technique, emphasis on spinning shot putting technique is still far from enough, and by investigation information, it indicates spinning shot putting technique is very suitable to Chinese athletes' practical situation. Therefore Chinese athletes should understand spinning shot putting technique with scientific eyesight, spinning shot putting technique still needs people to continue to excavate its potentials and values.

Spinning technique requires athletes more coordinate and sensitive, but it doesn't have high requirement of athletes' height and weight as well as other indicators, ac-

According to Chinese athletes their own features, strength features and better flexibility, coordination and sense of balance, it carries out comparative research on back sliding type and spinning type by data analysis, so as to make reasonable suggestions on shot putters' training.

SPINNING SHOT PUTTING TECHNICAL ANALYSIS

Holding technique

Five fingers nature separate, put ball on the root of index, middle finger and ring fingers, thumb and little fingers stick to ball's two sides so as to ensure ball stability. After well holding ball, put the ball inside fossa of clavicle, cling to neck, palm center put forward, and lift up elbow at the equal height of shoulder. Throwing arm and trunk forms into 90° angle, ensure throwing arm one side chest, back muscle moderate tension.

Ready position

After holding, back towards throwing direction, and stand inside throwing circle back edge. Two legs open, almost in the same width of shoulder, body gravity center falls between two legs. Spinning shot putting technique's ready position mainly has two types:

- (1) Two legs bend knees nearly 90°, upper body keeps relative straight.
- (2) Two legs slightly bend knees, upper body leans forward. It likes former Soviet Union athlete Baryshnikov.

In general, all adopt first ready position, it has advantages as following: When starting, spinning motions are slow, body gravity center is lower, motions range is larger, it can better activate muscle; easy to control balance; gradually increase human body gravity center and shot height let motions tend to continuity, let them more rhythmic; During spinning, flight ensures to be low and flat, human body gravity center has little up and down, avoid occurring upper body forward leaning status; After flight, it can more easily form into final exertion ready position.

Preliminary swing

The purpose of preliminary swing is to let human body achieve necessary rotational impetus before starting to spin. After standing back towards throwing di-

rection, body naturally slowly rotates rightwards. To offset opposite direction rotating force influence, left arm slight bends and naturally hangs down, whole body keeps straight or properly leans forward so as to propel to sport direction change to offset upper body excessive fast rotating leftwards. Body rotating rightwards extent is fixed according to individual status. Big and quick rotation is more prone to cause opposite direction rotating excessive fast response, in this way it is bad for entering into linear spinning and keeping body screwed and balance.

Spin

Spin is shot putting technique beforehand acceleration phase, excellent athletes let shot achieve 4-5m/s accelerated speed by spinning, former Soviet Union athlete Baryshnikov did better, he let shot arrive at 5m/s preliminary given speed by spinning, together with final exertion re-acceleration, let shot arrive at 13-15m/s release speed. Spinning throw is around 1.5-2m further than in situ throw (American Oldfield can let the gap arrive at 2.75m). The gap always is the important symbol to measure spinning technical quality. The purpose of spin is to accumulate human spinning kinetic energy for final exertion, let shot produce certain initial speed and so make preparation for final exertion forming into greatly accelerated exertion motion structure. Both the two must be given considerations, and forms into best cooperation. Complete spinning technique includes following aspects: two legs support starting; single leg support spinning, flight spinning; transition phase.

Final exertion and balance after releasing

Final exertion phase starts after left leg landing since right leg single support phase ending. At this time, athlete lower limbs have already entered into double support phase, pelvis and two legs have already been in relative fixed postures, and shoulder axis and hip axis are in larger screw state. Whole human body is under left leg stable support, in such case right leg right hip positive rotate and exert, throwing arms are not anxious to make initiative acceleration but accelerates following waist hip rotation. Meanwhile, left arm timely swings toward throwing direction, let chest muscle form into better beforehand extension which makes good preparation for subsequent final accelerated exertion phase that uses chest driving arms. On the basis of lower

FULL PAPER

limbs and trunk continuous forward acting forces, by left leg supporting exertion and left shoulder, left arm, left leg timely braking and cooperating with two legs pedaling and extending powerfully, chest out and stretch arms rapidly accelerated powerfully throw shot out. Whole body changes steps and turns left with inertia, and complete the whole motion.

MODEL ESTABLISHMENTS

T test model establishment

T test is using T distribution theory to deduce difference occurrence probability, so that comparing two average numbers difference is remarkable or not. It parallels to Z test, chi-square test. T Test divides into single ensemble test and double ensemble test.

Single ensemble T test is testing a sample average number and a known total average number difference is remarkable or not. When population distribution is normal distribution, and then sample average number and total average number deviation statistics is in T distribution. Single ensemble T test statistics is:

$$t = \frac{\bar{X} - \mu}{\frac{\sigma_x}{\sqrt{n-1}}}$$

Among them, \bar{X} is sample average number, μ is total average number, σ_x is sample standard deviation, n is sample size.

Double ensemble T test is testing two samples' average numbers and their respective represented totals differences are remarkable or not, it divides into two cases: independent sample T test and paired samples T test.

Independent sample T test statistics is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

Among them, S_1 and S_2 are two samples variances, n_1 and n_2 are two samples sizes.

Paired samples T test statistics is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sigma_{X_1}^2 + \sigma_{X_2}^2 - 2\gamma\sigma_{X_1}\sigma_{X_2}}{n-1}}}$$

Among them, \bar{X}_1, \bar{X}_2 are respectively two samples average numbers, $\sigma_{X_1}^2, \sigma_{X_2}^2$ are respectively two samples variances, γ is relative sample's correlation coefficient.

Data collecting

According to shot putters talent selection criterion, the paper selects height, back cast shot (4kg), in-situ shot put (4kg) and bench press four indicators. Received data results by statistics handling are as following TABLE 1 and TABLE 2 show.

By above TABLE 2, it is clear that A, B two groups indicators differences are remarkable, so we have reasons for dividing them into two groups, A group experimental group, B group contrast group.

Finally do test, extract average value from three times' performances. Standard meeting moment adopted shot weights are 3Kg, 4Kg, 5Kg, 6Kg. To easier checking spinning shot putting advantages, it is striving for getting a relative correct result.

In test process, it is up to professionals making data collecting on 3Kg, 4Kg, 5Kg, 6Kg four different magnitudes, ensure weights are correct.

A, B two groups test data is as following TABLE 3, TABLE 4, TABLE 5 show.

DATA ANALYSIS

A, B two groups' shot putting performance average values and standard deviations and others can refer to TABLE 3 to TABLE 5, Table 6 is two groups'

TABLE 1: Physical indicator

Item	Height(cm)		Back cast shot		In-situ shot put		Bench press	
	\bar{X}	S	\bar{X}	S	\bar{X}	S	\bar{X}	S
A	175	3.29	12.11	2.2	11.6	1.29	50.68	12.75
B	175	6.39	12.15	1.99	11.68	0.93	55.45	6.88

TABLE 2 : Physical indicator (T test)

Item	Height	Back cast shot	In-situ shot put	Bench press
T value	0	0.06	0.24	1.54
Different or not	×	×	×	×

Note: $T(0.05, 40) = 2.021$, $T(0.01, 40) = 2.704$, $n'42$, “×” represents difference is not remarkable, “*” represents difference is remarkable, “**” represents difference is very remarkable

TABLE 3 : 3 Kg shot

Item	In situ		Spinning/ Non-spinning		Differences	
	\bar{X}	S	\bar{X}	S	\bar{X}	S
A	12	1.56	12.5	1.37	0.5	0.86
B	12.1	1.19	13.6	1.38	1.5	0.76

shot putting performance T test result analysis.

From TABLE 3 to TABLE 5, it is clear that, in the level of 3kg, 4kg, 5kg, 6kg, two groups' in-situ shot putting performance differences are not remarkable, which indicates they have no big differences in final exertion. But throwing with integrity technique, their differences are relative obvious that can be seen from TABLE 6. In the level of 3kg, experimental group spinning shot putting average performance is 13.6m, contrast group back sliding shot putting performance is 12.5m, they has 1.1m gap, by T testing $P < 0.05$, significance difference is bigger. Also for 3kg shot, experimental group in-situ shot putting performance and spinning shot putting performance averagely have 1.5m gap, and contrast group in-situ shot putting and back sliding shot putting performance averagely have 0.5m gap, the two by T testing $P < 0.01$, difference is very remarkable. In the level of 4kg, experimental group spinning shot putting average performance is 12.4m, contrast group back sliding shot putting average performance is 11.9m, the two has 0.5m gap, by T testing $P > 0.05$, differ-

ence is not remarkable. Also for 4kg shot, experimental group in-situ shot putting performance and spinning shot putting performance averagely have 1.2m gap, and contrast group in-situ and back sliding performance averagely have 0.1m gap, by T testing $P < 0.01$, difference is very remarkable. In the level of 5kg, experimental group spinning shot putting average performance is 11 m, contrast group back sliding shot putting average performance is 10.8 m, the two has 0.2m gap, by T testing $P > 0.05$, difference is not remarkable. Also for 5kg shot, experimental group in-situ shot putting performance and spinning shot putting performance averagely have nearly 1.1 m gap, and contrast group in-situ and back sliding performance averagely have 0.6m gap, by T testing $P < 0.01$, difference is very remarkable. In the level of 6kg, experimental group spinning shot putting average performance is 8.65 m, contrast group back sliding shot putting average performance is 8.6 m, the two's difference is not remarkable. Also for 6kg shot, experimental group in-situ and spinning shot performance averagely have 0.68m gap, contrast group in-situ and back sliding performance averagely have 0.3m gap, by T testing $P < 0.05$, the difference is re-

TABLE 4 : 5Kg shot

Item	In situ		Spinning/ Non-spinning		Differences	
	\bar{X}	S	\bar{X}	S	\bar{X}	S
A	10.2	1.24	10.8	1.14	0.6	0.77
B	9.9	1.01	11	1.02	1.1	0.49

TABLE 5 : 6Kg shot

Item	In situ		Spinning/ Non-spinning		Differences	
	\bar{X}	S	\bar{X}	S	\bar{X}	S
A	8.3	0.95	8.6	0.89	0.3	0.61
B	7.97	0.74	8.65	0.86	0.68	0.4

TABLE 6 : Two groups' T test result analysis

Weight	3KG		4KG		5KG		6KG	
	Spinning/ Non-spinning	Differences						
T value	2.68	4.17	1.43	5.53	0.61	2.63	0.19	2.375
Different or not	*	**	×	**	×	**	×	*

Note: $T(0.05, 40) = 2.021$, $T(0.01, 40) = 2.704$, $n'42$, “×” represents difference is not remarkable, “*” represents difference is remarkable, “**” represents difference is very remarkable

FULL PAPER

markable.

It is well-known that in-situ shot putting performance and back sliding shot putting performance difference is a considerable important indicator to measure shot techniques merits. By above experiment data, it can also see that experimental in-situ and spinning differences are 1.5m, 1.2m, 1.1m, 0.68m, the average difference is 1.12m, and contrast group in-situ and back sliding differences are respectively 0.5m, 0.1m, 0.6m, 0.3m, the average difference is 0.375m. Among them, experiment group such indicator highest value is in the level of 3kg, difference is 4m (11.8m, 15.8m), contrast group such indicator highest value is in the level of 5kg, difference is 2.2m (7.5m, 9.7m).

CONCLUSIONS

By comparative analysis of above two throwing performance, it can get that experiment group, no matter in integrity technique throwing or in-situ and integrity technique throwing difference, it is higher than that of contrast group, perfectly indicating spinning superiority.

By analytic comparing of two groups' throwing techniques, from TABLE 3, it can get that in the level of 3kg, no matter integrity technique applied throwing or in-situ adopted integrity techniques performance difference, experimental group performance always is higher than that of contrast group, experimental group B athletes are pleased about the result, and lots of subjects general feel that they make motions, meanwhile feel motions very natural and continuous, and full of rhythm, final exertion motion is fully playing. Correspondingly, their 3kg levels technical evaluation scores are also relative higher, average score is 8.7 score. And contrast group in such level hasn't showed up any obvious advantages, its in-situ and back sliding only have 0.5m gap. Contrast group subjects generally feel that sliding and final exertion is difficult to connect, always stop will happen; correspondingly technical evaluation performance averagely is 8.2score.

But with shot its own weight increasing, both experiment group and contrast group performance are in decreasing trend. Among them, experimental group in 3Kg → 4 Kg → 5 Kg → 6 Kg, its average performance respectively reduces 8.1%, 11.3%, 21.4%, contrast group respectively reduces 4.8%, 9.2%, 20.4%, experimental group overall decreasing range is larger

than that of contrast group. Then, experimental group have also partial subjects' motions start to appear deformation, especially in 6kg weight level, it mainly highlights in transition phase. In the phase, many subjects show motions stopping (right foot landing stop), left leg strikes big arc, landing slowly and other phenomenon, which is also one difficulty and key point that spinning technique comes across. There are usually have following two reasons for above cases: one is court apparatus. Because athletics field establishment, spinning teaching proceeds in brick ground, when exercising, only can use solid sphere instead of shot to throw. Though throw solid sphere is a kind of good aids training way, after all it is not equal to shot. Because of upper body load increasing, it surely causes motions difficulties increase so that leads to motions instability. Second is because subjects haven't paid attention to their hips functions, without doing well in hips motions.

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