A STUDY OF THE RELATIONSHIP BETWEEN BIOMECHANICS PARAMETERS AND SPECIFIC PERFORMANCE IN DIFFERENT VERTICAL JUMPS OF FEMALE WEIGHTLIFTER

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The angle and its speed etc biomechanics parameters of hip and knee joint of 12 female lifters who adopted 5 different jump mode have been collected. Correlation analysis has been done between the collected data and specific performance. The result shows that different extent correlation between jump height in different mode and specific performance. In these correlations, biomechanics parameters in 60cm dropping jump have the most correlation factors. Especially elasticity energy utilizing rate and the height of dropping jump have the high extent correlation coefficient is about muscle speediness strength and muscle strength in allusion to female lifter. That is 60cm feasible height.

KEY WORDS: weight lifting, vertical jump, biomechanics, parameters

INTRODUCTION: The sport of female weightlifting is an athletic contest in which power is the foundation, and skill is the core. At present, power training methods employ some training ways with enormous energy expenditure and high intensity, especially the professional training, where the results improvement, based on mastering skills, is through load and intensity, only pays attention to power training that are the same with or similar to the profession, and always ignores the development of rapid power. Zhang Yue and others find that in order to develop the rapid power and the explosive power, contraction speed must be attached to enough importance. The load stimulation of high contraction speed can enhance the rapid mobilization capability of nerve muscle, which is very important to develop rapid power and explosive power. By the related analysis of the fundamental kinematics index, such as the speed and angle of hip and knee, and the results of weightlifting in five different vertical jumps in juvenile female weightlifting, some laws and characteristics can be found to help coaches and athletes in muscle rapid power training.

METHODS: The research objects are female professional weightlifting athletes in sports career team of Hebei Province. Average age 15.75 ± 1.54, average height 154.92 ± 5.74 cm, average weight 61.75 ± 9.49 kg. First testing athletes' professional results of snatch and clean-and-jerk, in the week before and after the experiment, then testing the objects by five different vertical jumps, researchers collect the biomechanics parameters of the angle and angular velocity of hip joint and knee joint of the weightlifting athletes. The vertical jump is divided into squat jump, counter movement jump, 20 cm drop jump, 40cm drop jump and 60cm drop jump. Electronic testing power analysis institute, Mechanics Department of Tsinghua University, produces three-dimensional testing power platforms. To prevent the testers from fear, the wooden enlarged surface is used around the platform, which enhances the stability of the testers' drop jump test. The testers have squatting jump on the platform at the beginning; that is to say, they jump from their suitable place with anti-direction prepared squat. In the counter-movement jump, the testers from the standing place, squat with anti-direction, then jump by force; the drop jump vertically from the platform rapidly. In every test, testers must have the hands on the waist without swinging arm, and try to keep the trunk straight to erase interference, and then the results can reflect the working conditions of extensor of lower extremity. Every jump is tested twice, and the better one is used to compute the needed numerical values.

The angle of hip joint's test uses self-made resistance angle joint measure apparatus, which measures the changes in angles and angular velocities of hip and knee in the five vertical jumps. Angle of knee joint's axis of rotation is overlapped with knee joint's axis of rotation, and the two apparatus' enlarged arms are overlapped with the line between the condyle of

thighbone and fibula. Apart from the line between the trochanter and trunk, it is the same with the hip joint one.

Analysis Method: Use SPSS11.0 to do the statistic work.

RESULTS: Related analysis of index of the hip and knee joints and special results in the squatting jump, counter movement jump and the drop jump of different height of 20 cm, 40cm and 60 cm.

From Table 1 and Table 2, it can be seen that there are comparatively few relations between the index and professional results of the hip and knee's joints in the two vertical jumps, but the starting angle of knee joint is related to the special results, whose relative index is about 0.6, and the starting angle is 114.69 ± 15.48. This result has a lot in common with Kangwei Ai's. In the counter movement jump, the largest angle speed of knee joint is related to the height of the special result, about 0.7. It proves that original vertical jump is influenced by training methods, and when the difference among athletes is small and the training level is at the same, the factors related to the results are concentrated and prone to be the same.

From the Table 3 Table 4 and Table 5, it can be seen that the height of vertical jumps of three different heights are all related to the specific performance. The related level of the 60cm type is the highest(r = 0.822). In them, KHA and HHA are highly related to the special results negatively, which reaches a level of 0.6. With the increasing height, KHA and HHA are prone to decrease. In the 60cm drop jump, HHA is 104.98 ± 26.11, and KHA is 96.32 ± 15.79, which is the same with Songhua Mao's result that the extensor of hip joint reaches the apex moment at 90. Besides, KCS and KSA also get a different relation with the special results, which reach the level about 0.5. In the 60cm drop jump, KSA is 822.13 ± 199.67, a little higher than 520, which is the average centripetal speed in the state of snatch by Yue Zhang. The difference may be ascribed to the apparatus, specimen and psychology. However, KES in the 60cm drop jump is 136.25 ± 10.77. Research shows that when the athlete's KBA is about 125,his or her quadriceps initiative contracting change to passive recession from the driving one, the angle of knee is in the best state of power explosion. The conclusion conforms to the research result.

From the statistics result of Table 1-5, only in the 60cm drop jump is the utility rate of elasticity energy related to the height of the special result, which reaches a level about 0.7. This result is resulted to the muscle's working form in the 60 cm drop jump. In this type when the athlete the athlete drops and then jump, muscle covers SSC (Stretching Shortening Cycle), which is reported a lot and scholars and power training experts agree on that in SSC process, muscle's kinesis unit's mobilization amount and rate improves clearly.

Table 1 Correlation coefficient of kinematics index and specific performance in squatting jump.

	HIHG	HBA	HCS	HSA	KBA	KCS	KSA	CT	CI
S/W	.378	-.483	.287	-.469	-.615*	.748**	-.028	.105	-.245
CJ/W	.452	-.571	.385	-.378	-.508	.459	.025	.000	-.385
T/W	.469	-.601*	.364	-.441	-.587*	.552	-.049	.084	-.301

Remark: * $p < 0.05$, ** $p < 0.01$.

S/W=snatch performance/weight, CJ/W=clean and jerk performance/weight, T/W=total performance/weight HIHG=height of vertical jump, HBA=starting angle of hip, HCS=max centripetal angle speed of hip, HSA=angle of hip in max speed, KBA=starting angle of knee, KCS= max centripetal angle speed of knee, KSA= angle of knee in max speed, CT=time of centripetal phase, CI=impulse of centripetal phase

Table 2 Correlation coefficient of kinematics index and specific performance in counter movement jump.

	HIHG	HCS	HES	HSA	HHA	KBA	KCS	KES	KSA	KHA	ER	CT	ET	CI	EI
S/W	.587*	.049	-.150	-.187	-.469	-.286	.580*	.231	-.699**	-.357	.174	-.178	-.017	-.426	-.318
CJ/W	.532	.225	-.204	-.255	-.455	-.238	.235	.273	-.729**	-.245	.158	-.269	-.088	-.485	-.333
T/W	.566	.144	-.185	-.228	-.503	-.267	.336	.265	-.797**	-.322	.163	-.239	-.054	-.483	-.324

Remark: * $p < 0.05$, ** $p < 0.01$.

S/W = snatch performance/weight, CJ/W = clean and jerk performance/weight, T/W = total performance/weight HIHG = height of vertical jump, HCS = max centripetal angle speed of hip, HES = max centrifugal angle speed of hip, HAS = angle of hip in max speed, HHA = max cushion angle of hip, KBA = starting angle of knee, KCS = max centripetal angle speed of knee, KES = max centrifugal angle speed of knee, KSA= angle of knee in max speed, KHA = max cushion angle of knee, ER = utility ratio of muscle elastic energy, CT = time of centripetal phase, ET = time of centrifugal phase, CI = impulse of centripetal phase, EI = impulse of centrifugal phase.

Table 3 Correlation coefficient of kinematics index and specific performance in 20 cm drop jump.

	HIHG	HCS	HES	HSA	HHA	KBA	KCS	KES	KSA	KHA	ER	CT	ET	CI	EI
S/W	.373	.308	-.037	-.573	-.427	-.270	.513	-.189	-.409	-.238	-.107	.117	.335	-.444	-.133
CJ/W	.661*	.690*	-.267	-.739**	-.578*	-.320	.351	-.067	-.405	-.343	.141	.194	.440	-.464	-.006
T/W	.627*	.594*	-.163	-.769**	-.580*	-.308	.428	-.114	-.420	-.378	.040	.165	.405	-.463	-.053

Remark: * $p < 0.05$, ** $p < 0.01$, (Note of each index is as same as Table 2).

Table 4 Correlation coefficient of kinematics index and specific performance in 40 cm drop jump.

	HIHG	HCS	HES	HSA	HHA	KBA	KCS	KES	KSA	KHA	ER	CT	ET	CI	EI
S/W	.721**	.277	-.156	-.348	-.601*	-.557	.583*	-.450	-.637*	-.664*	.530	.316	.504	-.227	-.069
CJ/W	.744**	.510	-.193	-.481	-.637*	-.459	.390	-.319	-.582*	-.525	.519	.398	.328	-.085	-.310
T/W	.750**	.411	-.177	-.433	-.664*	-.515	.482	-.373	-.621*	-.615*	.534	.377	.410	-.137	-.211

Remark: * $p < 0.05$, ** $p < 0.01$, (Note of each index is as same as Table 2).

Table 5 Correlation coefficient of kinematics index and specific performance in 60 cm drop jump.

	HIHG	HCS	HES	HSA	HHA	KBA	KCS	KES	KSA	KHA	ER	CT	ET	CI	EI
S/W	.796**	.240	.296	-.253	-.552	-.361	.494	.018	-.636*	-.399	.734**	.116	.273	-.202	-.165
CJ/W	.813**	.407	.327	-.220	-.718**	-.414	.285	-.039	-.518	-.588*	.734**	.278	.449	-.139	-.034
T/W	.822**	.340	.323	-.236	-.713**	-.403	.381	-.010	-.584*	-.580*	.747**	.214	.387	-.166	-.081

Remark: * $p < 0.05$, ** $p < 0.01$, (Note of each index is as same as Table 2).

DISCUSSION: In spite of good special power of weightlifting, researches show that there is an imbalance in the muscle development of weightlifting athletes in China, which is extensor's power better flex's one, whose rate is between 0.5 to 0.6, but an excellent world athlete's rate is 0.8 to 1.0. Besides, training amount and intensity are stressed in normal times' training, which limits the muscle's shortening speed when finishing an action, and thus influences the development of muscle fastening power and explosive power. A study shows that knee joint's extensor unit's weight's power level is that: Track and field> rowing > weightlifting. In view of problems in weightlifting training, the training of muscle fastening power's centripetal shortening ability and centrifugal force training should be strengthening, to enhance the utility rate of muscle's elasticity and improve the explosive power of muscle. Deep jump is a training method employed much at present, but there is no ideal method to choose a appropriate depth, for different depths have different effects on muscle fastening power and centrifugal force of muscle. Some material shows that the appropriate depth is related to the special parts. From this study, the type of 60cm is related to special results, especially the vertical jump height and elasticity utility rate, which helps much to the fastening

power and explosive power. Therefore, it is suggested that coaches employ 60 cm drop jump as the special numerical value, which needs more study.

CONCLUSION: Through five types of drop jump of weightlifting athletes, hip and knee kinematics index and weightlifting special results; it is found that different depths of jump have different relations with the special results. Among them, the 60cm type gets a relative level of 0.8 with the height of special results. Therefore, the utility rate of elasticity can be an indirect level to consider athlete's special results. From the statistics, it can be seen that only in the 60cm drop jump is the utility rate of elasticity related to the special results, about 0.7. This index shows the muscle's rapid shortening capability. Therefore, drop jump is put forward as an important training method of muscle's rapid capability in weightlifting, and 60cm is the ideal depth of the drop jump in the related analysis.

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