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The Comparison of MUSCLE POWER Related Main Techniques and Exercise Ability according to the Athletic Capacity of Male Middle School Handball Player

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Abstract

Purpose: The present research aimed to analyze the breach between various groups under differing conditions by estimating and comparing the use of main techniques and exercise ability related to muscle power, which has influences on the athletic capacity of major and minor male middle school athletes for handball games. It also aims to offer rudimentary data for the fostering of muscle power of such athletes in the future, and enhance their capacity midst games.

Method: The subject of the research consisted of 8 major handball athletes and 8 minor handball athletes of N middle school in G district. The position of players in the 49th National Gymnastics Competition for Boys which took place in 2019 served the criteria with which major and minor athletes were divided: the main players midst the winning of the finals were classified as major, and the substitute players were classified as minor. For the estimation of muscle power, tests in hurling, jumping, short distance running and muscle endurance were conducted. The data processing was analyzed using the SPSS 18.0 statistics program, and the average and standard deviation were calculated per section. In order to find the difference between major and minor athletes, independent t-tests were conducted and all statistical significance level was set at $p < .05$.

Results: Among 7 categories of muscle power estimation related to major techniques which determine the winning or losing of handball games, the major players' records displayed a meaningful superiority in vertical jumping, standing long jumps, 30 meter sprints and 30 seconds push ups. Also, in other categories of muscle power estimation, the major athletes showed capacities exceptionally superior to that of minor athletes, although not amounting to a meaningful difference.

Conclusion: Conclusively, we can analyze that regarding the muscle power which has major influences on the handball playing ability of male middle school students, the ability to jump, sprint short-distance, and foster upper body muscle endurance are important since they contribute to major and specialized movements related to scoring.

[Keywords] Male Middle School Handball Players, Muscle Power, Jumping Ability, Ability to Sprint Short Distance, Upper Body Muscle Endurance

1. Introduction

Handball is a game in which sprinting, running, throwing, consistent jumping and stepping is done in a field of endline 20m and sideline 40m, and one which consists of a combination of muscle power related techniques and the tactical enacting of movements. In a handball game, the strikers reach the goal area of the opponent through dribbles and passes and makes a shot against the defence in front of them, or with swift passes and feinting, overtakes the final defender, goes through, and jumps in from outside the goal area and succeeds in scoring. As for the defense players, they are expected to halt the strikers with forceful body slamming

and fouls as much as the rules of the game allows, and hinder or block the connecting of the passes to not allow the opponents the chance to score, and relay the ball to the goal keeper of the defending team so that the ball would belong to the defending team which would then be converted to the side striking. Thus, handball games can be seen one in which there is an intense struggle between the strikers and the defense players near the goal area line and free throw line, and in which swift attack movements continue in a turnover [1].

Handball games allow fouls according to the attributes of the game and thus physical contact such as fierce body slamming occurs quite often, and a prior research has validated that Korean handball players have good muscle traits, since much time and effort is spent in order to improve maximum strength and the power of muscles to overcome the inferiority in terms of body build in matches against European players [2]. Thus, the coaches and players on site are keenly interested in ways in which muscle power could be enhanced [3].

Muscle power has to do with the ability to make possible the execution of large amounts of tasks in limited time in active movements, such as jumping high or far, moving swiftly, and throwing an object. It is one of the most consequential element of body strength which affects ability in sports games and even results in victory or failure. Muscle power also has a keen relationship with agility, and is a kind of power exerted by momentary muscle contraction while the player is in movement. Muscle power has to do with the ability in which the muscle contracts instantly and exerts much power, and is often determined by how effective is the balance between the functional faculties of the nervous system and the muscles. The form in which such an energy is expressed is determined by the stimulation threshold of the sensory system, the amount of time taken to determine judgement by the central nervous system, and finally, the speed of neuro-transmission and muscle contraction [4].

Muscle power becomes necessary when the concentration of nervous impacts causes the muscles to contract, and the more the momentary contraction of the muscles, the more the physical ability to act. Muscle power is divided into the transverse power and vertical power, and is the ability to wield maximum ability in the shortest possible time, and also can be seen as the rate of the task done within a time unit. Muscle power, according to the strength and speed, could differ in two-folds and three-folds [5][6][7].

According to a previous research, the muscle power midst the process of exercise can be measured according to the distance in which the body and objects can be propelled through a certain space. It can also be affected by body structure and the viscosity of muscle weight. According to the research, there is a high level of relevance between muscle power and jumping trials [8]. Also muscle power can be examined through having subjects jumping backwards from a fixed position, and checking the power to throw balls and the ability to run short distances. In particular, midst matches, muscle power is one of the most important physical attributes which determines the ability to exercise, and serves a major part in running, jumping and throwing, all of these the basic activities which forms all sport techniques and consists active exercise [9].

The enhancing of muscle power have a toll on the ability to play in all kinds of sports, and it is the ability to exert maximum strength in minimum time, including many kinds of movements which use much muscle force in an instant among moves in gymnastic and sports. That is to say, taking into account the total amount of work in which a determined weight will move a certain distance during what span of time, the intention is to maximize muscle power used within a minimum span of time, the ultimate goal being intensifying muscle power and enhancing the speed. Muscle power is deemed an important bodily factor which affects the performance of elite players [10]. However, regarding the researches in which the relationship between the variables of techniques, which influences handball games, and physical ability, scarce is a research taking into account major and minor athletes in middle school (7th-9th grade, American system) Thus, the present research compares major techniques and exercise abilities related to muscle power, which massively affects the ability for taking part in handball games, among major players and minor players in middle school handball games for boys,

taking note of discrepancies between groups, and offering rudimentary data for improvements in techniques and ability to play related to muscle power.

2. Research Method

2.1. Subjects

The subjects of the present research consisted of 8 major players and 8 minor players among the 16 handball athletes in N middle school, G district as recorded by the Korean Sport and Olympic Committee. The criteria determining major and minor athletes was the position they took in the 49th National Gymnastic Competition for Boys year 2019, where those who were main players were classified as major, and the substitutes minor. The subjects got full explanations prior to the research on its purpose and procedures and took part voluntarily, and they participated 1 week after the competition ended. <Table 1> describes the physical attributes of subjects.

Table 1. The physical traits of subjects.

Group \ Trait	Age	Height (cm)	Weight (kg)	Muscle amount (kg)	Body fat (%)	Lean mass (kg)	Body mass rate (kg/m ³)	Player
Major athletes	14.03 ±0.92	168.29 ±6.48	57.99 ±7.29	47.88 ±6.89	7.55 ±6.25	50.91 ±6.86	20.47 ±3.56	8
Minor athletes	14.02 ±0.79	168.78 ±5.34	57.98 ±6.58	46.69 ±4.62	8.12 ±4.26	50.85 ±3.79	20.65 ±2.05	8

2.1.1. Body composition

On the day of the experiment, the subjects participated 10 hours after the last meal, after relaxing in a lab in a state of fasting for 15~20 minute. We used the product from the Inbody 720 Biospace firm(KOR), and had the subject dress as lightly as possible as to not hinder body weight estimation, and with them climbing atop the device and contacting hands and feet to the circuits, the body fat, lean mass, body mass rate, and muscle amount were measured.

2.2. Muscle power capacity

In order to estimate muscle power a number of tests were conducted. An evaluation on the ability to throw took place with basketballs and handballs. One evaluation on jumping ability was done with tests on jumping high or far in place, and one was done on speed through 30 meter running which took place twice, among which the maximum rate was recorded. Recorded were the muscle power in gripping, in consideration of the power to take hold of the ball in order to throw it, and the muscle power of the abdomen, in consideration of fierce and continual struggles in defence and attack moves. Taking into account the muscle power and muscle endurance of the upper body which are necessary in the first and second half related to swift passes and shooting, records of sit-ups and push-ups were taken.

2.2.1. Basketball throwing

The subject had his back at a right angle, leaning on a flat bench fixed against a wall, and was asked to push the basketball with only the power of the upper limb. As for the order of estimation, the baseball was grasped at both sides with both hands, held at the right angle from the chest, and with the back pressed against the surface, with only the muscle power of

the arm, the ball was handled by the subject. Here, the subject was controlled to not have his back off the wall. The distance of estimation was measured determining the distance from the tip of the subject's hand to the place where the basketball landed, and was recorded by centimeters with a tape measure. Tests were done three times and the maximum rate was recorded.

2.2.2. Handball throwing

Handball throwing is one of the most important functions of a handball player, and it is crucial that an accurate throw at a fast speed be done midst passes or shootings. It is the skill of relaying explosive power to the ball in minimum time, with the lower body, the waist, the muscle power of the upper limb and others working together, and can be seen appropriate for measurement in this particular study. As for the way in which the measurement was made, the subjects were allowed free movements in a circle of a diameter of 2 meters, and were asked to throw the handball with the movement they made in their training, without the jump. The estimation of the distance was made from the beginning of the foothold to the place the ball first landed with a tape measure(Komelon, Korea) in centimeters. The records were taken three times and the maximum rate was recorded.

2.2.3. Vertical jump

This is a means of estimation where vertical jumping ability is recorded, taking use of JS-D80 of Yagami, by having the subject spread his arm upward, and taking use of the location and rebound, evaluate the most prominent difference between the height reached and the initial height. In order to estimate, the subject stood in front of the device with both feet together, and after raising the arm near the device and by touching and recording the tip of the hand with both feet on the ground, jumped using the rebound of knee, waist and arm, and reached for the touchpad at the highest spot. The digital jump meter of the recording were in centimeter units, and the maximum record midst 3 trials was taken as the estimate.

2.2.4. Standing long jump

The standing long jump was done with the feet fixed on the treading block without a running start, with appropriate rebounds front and back, up and down, and finally through jumping. After warming up on the measuring board with feet at shoulder width, and after 2 to 3 rebounds using the knee, arm and waist, the subject was asked to jump. The distance between the starting line and the nearest ankle which reached the measuring board was recorded. The unit were centimeters, and the maximum record midst 3 trials was taken as the record.

2.2.5. 30m running

The above means of recording was done on the international athletic standard track, where after the distance was estimated beforehand, laser sensors were installed on the starting and finish line, and once the subject was ready he was asked to run at fastest rate. After passing the laser sensor at start line and end line, the rate was recorded automatically. The unit was in seconds(m/s), and the maximum record midst 2 trials was taken as the estimate.

2.2.6. 30 second sit-ups

Fixing the feet on one side of the measuring instrument(Welltech Co, Korea) and with two hands folded behind the head, the subjects were asked to have their elbows touch their knees for 30 seconds after the starting call. The maximum rate of repetition was recorded.

2.2.7. 30 second push-ups

The subjects were expected to have both hands at shoulder width, join their feet together, and have arms at a right angle. With the starting call, they were expected to have elbows at more than 90 degrees and the chests lightly touch the floor. Such movements were executed for 30 seconds, and the maximum rate of repetition was recorded.

2.3. Data analysis

In order to manage the data for this research, the SPSS 18.0 statistic program was used for analysis, and the average and standard deviation was calculated. An independent T-test was used in order to find the difference in muscle power between major and minor athletes, and all the level of statistical relevance was set at $p < .05$

3. Results

3.1. Throwing ability

<Table 2> is the result on the throwing ability among muscle power evaluations of major and minor athletes. There was no relevant difference in the two group's ability to throw basketballs and handballs.

Table 2. Comparison of throwing ability(unit: cm).

Sector	Category	Minor athletes	Major athletes	<i>p</i>
Throwing ability	Basketball throwing	540.87±51.66	562.68±88.29	.568
	Handball throwing	3321.54±38.65	3669.35±692.78	.349

3.2. Jumping ability

<Table 3> is the result on the jumping ability among muscle power evaluations of major and minor athletes. The category of vertical jump displayed a meaningful difference($p < .01$), with major athletes at 48.75±3.44cm, and minor athletes at 40.89±4.35cm. Standard long jump also displayed a meaningful difference($p < .05$) with major athletes at 235.78±13.48cm, and minor athletes at 210.53±16.51cm.

Table 3. Comparison of jumping ability(unit: cm).

Category	Minor athletes	Major athletes	<i>p</i>
Vertical jump	40.89±4.35	48.75±3.44*	.001
Standard long jump	210.53±16.51	235.78±13.488*	.029

Note: * $p < .05$.

3.3. Speed

<Table 4> is the result on speed among muscle power evaluations of major and minor athletes. In the sprint test evaluating speed showed a meaningful difference with major athletes at 4.59±1.25sec, and minor athletes at 4.96±0.21sec.

Table 4. Speed comparison(unit: sec).

Category	Minor athletes	Major athletes	<i>p</i>
30m Sprint	4.96±0.21	4.59±1.25*	.014

Note: **p*<.05.

3.4. Muscle endurance

<Table 5> is the result on muscle endurance among muscle power evaluations of major and minor athletes. In 30 second sit-ups, no meaningful difference was derived with major athletes at 33.51±4.51 [3], and minor athletes at 31.05±3.87. In 30 second push-ups, major athletes scored 39.58±5.24 times, and minor athletes scored 29.45±8.35 times, a meaningful difference.

Table 5. Comparison of muscle endurance.

Category	Minor athletes	Major athletes	<i>p</i>
30 second sit-ups	31.05±3.87	33.51±4.51	.756
30 second push-ups	29.45±8.35	39.58±5.24*	.028

Note: **p*<.05.

4. Conclusion

In order to lead a handball match to victory, it is necessary to score the most and lose points the least. To score, a shooting which can lead to a goal-in is needed. Among shootings, there are 1:1 no-mark shootings, done against the goal keeper after a swift attack, and powerful jump-shootings and diving shootings, formed through tactical movements and passes. To keep from losing score, continual and fierce body slamming with strikers in the defense zone, and blocking jumps to halt shooting and to retrieve the right to attack, needs to be done consistently. Also, after succeeding in blocking or after losing score, a sprinting at maximum speed needs to be done to the opposition's den before the opponents can reach it. That is to say, handball games consist of movements of running, jumping and throwing, some before shooting which are close linked with scoring, some intended to keep from losing scores.

While movements of muscle endurance, a parameter of muscle power measurement, can be done with a single movement, namely the blocking jump to keep the opposition striker from scoring, in handball matches most of the movements are combinations of more than two skills among running, jumping and throwing. When rushing towards the opposition den for a rapid deployment, for instance, swift passes are made while running, and before a powerful strike, with a rapid sprint, athletes make a running start then proceed to a shoot. Taking into account the attributes of handball games in which all movements related to the winning and losing include those of muscle endurance, the present research estimated and compared the factors of muscle power in male adolescent major and minor handball athletes.

According to the present research, among the seven major muscle power abilities which affect handball games, major athletes proved a meaningful statistical superiority against minor athletes in categories such as vertical jumps, standing long jumps, 30 meter running, and

30 second push ups. Also, since major athletes achieved better records in all fields of estimation than the minor athletes, we could conclude that muscle power ability and techniques have an important effect on the ability to excel in handball games, which is why the importance in training for muscle power needs emphasis.

The standard makings of an accomplished striker in handball games is the ability to score or assist, and in a research between the physical abilities of handball athletes and the accuracy of a medium-distance shoot, there is a relevance between medium distance shoots and vertical jumps[11]. This denotes that the ability to jump, higher and with more force, enhances the accuracy of a shooting which may lead to scoring, and have the opposition defence come forth, so assisting a goal. In the present research, the ability to jump vertically on the part of major athletes was far better than that of minor athletes, which coincides with the results of the prior research.

Diving shoot is a movement as frequently made as the jump-shoot, which leads to scoring. It is a shoot made by jumping nearest to the goal post from outside the goal area, and, assisted by fellow players, throwing the ball before landing on the ground. Since this movement is not assisted by a running start, the possibility of scoring is enhanced by jumping the farthest and highest, maximizing the time in the air. In standing long jumps, measured by making such specifics of technique into account, meaningful superiority was found in major athletes in comparison with minor athletes, in which the prior and present research agrees that muscle power had high relevance with the ability to jump.

In 30 meter running, the major athletes had meaningfully higher statistics than the minor athletes. Often, in handball games, after a rapid deployment and scoring during the first and second half, athletes participate full speed in defence to halt opposition attacks. In international handball games, the average distance moved during one time midst the first and second half were 14~23 meters for 70% of the subjects, and movements were made by 6.5~9 meters per second[12]. In the present research too, in the ability to sprint short distance, a crucial element determining the capacity for handball games, meaningful superiority was found in major athletes compared to minor athletes.

The ability to jump vertically and execute 30 meter sprints usually involve movement of the same sort, and take use of a corresponding body part[13]. In fact, the report that the athletes with better vertical jumping ability is also found to have exceptional ability in maximum speed sprinting[14], and the report emphasizing the importance of power evaluation of adolescent athletes and one that says vertical jumping and standing long jumps have relevance to 30 meter running, advocates the present research[15]. Also, as a factor which affects muscle power, muscle fiber composition ratio can be mentioned. It is presumed that according to the attributes of the game, handball games which has similarities with basketball games, will have higher usage of fast muscle fiber among the muscle fibers deemed important in games lasting for a long time. As it is known that a basketball player's gross fast muscle fiber reaches the percentile of 45~69%[16][17], it can be presumed that handball athletes are of similar conditions. It is thought that there is a need to study fast muscle fibers, which affect muscle power, in detail.

Handball games require the muscle power of the upper body, where body slamming in which the opposition must be pulled and pushed midst attack and defense, and where fast passes and shootings must be done consistently. In the 30 second push-up estimation, the major athlete had meaningful superiority against the minor athletes. Taking into account the importance of shoulder and swing movements in handball games, a big breach between major athletes and minor athletes was expected but there was no meaningful statistic relevance. In a previous research the endurance level and anaerobic power differs according to muscle mass[18], and in teenage years the height of adolescents increase rapidly while the lean mass including muscles did not increase significantly, developing at later teenage years[19]. The physical attributes of major and minor groups of the research almost coincided in terms of muscle amount and lean mass. While adolescents about 14 years old see their muscle power

and muscle contraction rate in their lower body improve and that of the upper body develop late, once taking into account the enhancing of muscle contraction speed, a result like that of the present research was derived.

Muscle power can be seen in concepts of power and speed which involves the concentration of nervous shock, and is the ability to swiftly enact a power of a muscle contraction within a limited time. The power aforementioned denotes that of a muscle and the speed has to do with the speed of muscle contraction[20][21]. In the present research, the categories of muscle power estimation in which major athletes scored higher than minor athletes were closely related to main movement techniques which determine winning or losing in handball games. In vertical jumping, standing long jumps, 30 meter sprints and 30 second push ups, the major group showed better results in comparison to the minor group, and while there was no significant difference in terms of the unit of muscles involved, it can be concluded that, due to repeated training and experience, the central nervous system's judgement processing time and nerve transmission speed of the major athletes had advanced and with the muscle contraction rate quickening the muscle power overall have improved[22]. Also, according to the physical development of adolescence, it is seen that the muscle power and muscle endurance of the upper and lower body will be relatively different between stages, and detailed research seems necessary.

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6. Appendix

6.1. Authors contribution

	Initial name	Contribution
Lead Author	THK	-Set of concepts <input checked="" type="checkbox"/> -Design <input checked="" type="checkbox"/> -Getting results <input checked="" type="checkbox"/> -Analysis <input checked="" type="checkbox"/> -Make a significant contribution to collection <input checked="" type="checkbox"/> -Final approval of the paper <input checked="" type="checkbox"/> -Corresponding <input checked="" type="checkbox"/>
Corresponding Author*	KJK	-Play a decisive role in modification <input checked="" type="checkbox"/> -Significant contributions to concepts, designs, practices, analysis and interpretation of data <input checked="" type="checkbox"/> -Participants in Drafting and Revising Papers <input checked="" type="checkbox"/> -Someone who can explain all aspects of the paper <input checked="" type="checkbox"/>