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# COMPARISONS OF ANAEROBIC PERFORMANCE AND ISOKINETIC STRENGTH IN KOREAN AND JAPANESE FEMALE COLLEGIATE WRESTLERS

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## ABSTRACT

The purpose of this study was to examine and compare the anaerobic performance and knee isokinetic strength in Korean and Japanese female collegiate wrestlers ( $n=6$ ,  $n=10$ ). Testing variables included body composition, Wingate Anaerobic Test (WAnT), and an isokinetic leg strength test. These data were used to diagnose the subjects' physical capability necessary for elite female wrestlers and to compare the data from the two countries. Comparisons between these data were calculated using the independent t-test method. The results of this study were as follows: WAnT, total work (TW), mean power (MP), and peak power (PP) were significantly ( $p < 0.05$ ) lower in Korean female collegiate wrestlers, respectively. During isokinetic dynamometer testing at only velocity  $180^\circ/\text{sec}$ , isokinetic strength and power output in right knee extension were observed to be significantly ( $p < 0.05$ ) lower in Korean female collegiate wrestlers. In conclusion, these findings suggest that these indicators may be determinants of female wrestlers' performance. Additionally it seems that wrestlers and their coaches should take into account the principles of specific and individual training for improving anaerobic capacity and knee isokinetic strength.

**KEYWORDS** female wrestler, anaerobic performance, isokinetic strength, wrestlers' performance factor

## INTRODUCTION

One of the most important factors in maximizing the power during a wrestling match is securing basic muscular strength to execute high technique. During a match, strong muscular strength, muscular power and muscular endurance are essential to overcoming a competitor's resistance to attacks and defense, to maintaining a balanced posture against the competitor's attack, and to beating the competitor's attacks and also, attack the opponent technically (22). In sports where power or muscular endurance are the main factors, suitable methods can be selected. When power and endurance are demanded at the same time, suitable training methods and training time have to be reflected at a suitable rate between these two demands. So, wrestling instructors must make their efforts to recognize the importance of a special physical fitness for the special demands of wrestling. At the same time, they must first of all, identify the factors of the special physical fitness for wrestling, and must measure and analyze the physical fitness level in these physical fitness factors.

The anaerobic exercise capacity in wrestling matches is utilized as an important factor in succeeding in international matches (4). Studies on anaerobic exercise capacity of physical factors affecting high match ability in adolescences matches (1), university runners (12), and national wrestlers (20,21), which can be used as important materials for identifying and establishing performance levels for specific physical fitness parameters. Anaerobic metabolism capability is a factor demanded when a player takes a high intensity exercise for a short time, as in wrestling. Of the many physical fitness factors involved in wrestling, isokinetic muscular power and anaerobic power, isokinetic leg muscular endurance and lactic acid endurance are important special physical fitness factors in assessing wrestling match capability. Regarding the physical strength factor of isokinetic strength; we have data targeting national male wrestlers (20), American football (7,15), and soccer players (10); high school male wrestling player in the USA (5,18), youth wrestlers in Turkey (11), and junior national male wrestlers in Iran (13).

Female wrestling was included in the Olympics in Athens Olympic in 2004. So, most studies on anaerobic power of wrestlers have targeted male wrestlers. However, there are a few studies of women that have assessed their performance on anaerobic capacity and isokinetic muscular function (6). All age classes have not been targeted among female wrestlers (17). It has only been 6-7 years since female wrestling has been introduced in Korea and a national competition has been held. In order to gain financial support for further growth, studies regarding

female wrestling should be made, so it will grow and the wrestlers can achieve in competition. Active study is demanded.

This study aims at analyzing the anaerobic motion ability and constant speed muscular function, important factors in wrestling matches, comparing Japanese and Korean female university wrestlers, and at the same time establishing physical training targets and methods for Korean wrestlers.

## METHODS

### Experimental approach to the Problem

It is advised to measure and assess relevant numbers of any sport events in the field, and there are often event-specific features or a number of environmental factors that make the field measurement unavailable. In contrast, laboratory measurement and assessment can lack specificity to the sport, but the reliability and validity of measuring instruments are found to be higher. Thus in the study as well, the author chose to measure the values of WAnT and Isokinetic strength in a moderate condition.

### Subjects

The subjects were 16 females, all of them collegiate wrestlers. All subjects voluntarily participated in this study. None of the subjects reported neurological diseases or recent injuries. The descriptive characteristics of the subjects are presented in Table 1.

Table 1. Physical characteristics of the subjects.

Group	Age	Career(yr.)	Weight(kg)	Height(cm)	Fat(%)	BMI
KOR (n=6)	19.7±0.8	3.8±1.5	60.1±7.4	159.3±5.7	23.0±5.1	23.7±1.7
JAP (n=10)	19.5±1.6	10.1±3.2	66.1±10.4	160.0±4.3	19.1±6.5	25.7±3.2

KOR = Korea; JAP = Japan, Values are means ± SD.

### Procedures

The study measured body composition, isokinetic muscular function, and anaerobic exercise capacity in that order. All measurements were carried out at the Korean National Sport University in South Korea.

*Body Composition.* This study performed a body composition measurement with an InBody 4.0 (Biospace™, Korea) impedance analyzer. The parameters observed were body composition (intra & extra cellular fluid (L), protein (kg), mineral (kg), muscle & fat (weight (kg), skeletal muscle mass (kg), fat mass (kg)), obesity diagnosis (BMI, %fat, waist-hip ratio), and lean balance (right, left arm and leg (kg), trunk (kg)) etc.

*Anaerobic Exercise Capacity.* The ability to do anaerobic capacity reflects on the ability to convert energy from anaerobic pathways, based on the theoretical background that the the results will reflect peak anaerobic power, average anaerobic power and total work from the 30 seconds test (8,9). This study measured anaerobic maximum power on equipment made for this purpose (Lode Excalibur, Netherlands.) The exercise load method was to do warm-up for about 2-4 minutes with the intensity of 150-160 HR/min and to take a rest for about 3-5 minutes before doing a test, set up the load of applied as the 0.05kp to subjects. The main exercise made the subjects pedal as fast as possible with the maximum speed so that they could reach the concluded load within 2-4 seconds continuously and display explosive power for 30 seconds continuously. The measurement variables were analyzed to be MP (W), PP (W), total work (TW, J), and fatigue index (FI, %).

*Isokinetic Muscular Function.* The isokinetic muscular functions were measured with an isokinetic dynamometer (Cybex Humac Norm, USA). The muscular endurance was performed by the Davies (2) method, basing on the report on the study that dynamic strength of athletes has to be measured at 60°/sec for slow load speed and 240°/sec for fast load speed (14,16). Measurements were also performed at 180°/sec (23), the medium load speed, basing on the report that it was difficult for muscular power to be displayed when movement was too fast or too slow because the coordinative action could not be executed (14). Therefore, muscular power was measured with three repetitions at 180°/sec and muscular endurance with 26 repetitions at 240°/sec. The measurement variables were absolute muscular strength (Nm), relative muscular strength (%BW), average power

(W), total work (J), ipsilateral balance ratio (%), and bilateral balance ratio (%) on peak torque per muscular function of the knee joints.

### Statistical Analysis

All data were reported as mean  $\pm$  SD. Data were analyzed using an independent t-test by using SPSS for Windows, version 16.0 (SPSS, Inc., Chicago, IL). Statistical significance was set at  $p < 0.05$ .

### RESULTS

The results from the Wingate anaerobic test (WAnT) are shown in Table 2. During the 30 seconds of lower body cycling, total work, mean power, and peak power were observed to be significantly ( $p < 0.05$ ) higher in Japanese female collegiate wrestlers than in the Korean female collegiate wrestlers, respectively. Fatigue index was not significantly different between the two groups.

Table 2. Results of WAnT in Korean and Japanese female wrestlers.

Group	TW		MP		PP		FI
	Kpm	Kpm/kg	W	W/kg	W	W/kg	%
<b>KOR</b>	10935.0	194.0	364.5	6.5 $\pm$ 1.0	434.8	7.7 $\pm$ 1.2	8.7 $\pm$ 3.2
<b>(n=6)</b>	$\pm$ 1812.4	$\pm$ 29.0	$\pm$ 60.4		$\pm$ 71.4		
<b>JAP</b>	13914	219.6	463.8	7.2 $\pm$ 0.4	550.6	8.6 $\pm$ 0.5*	7.9 $\pm$ 3.0
<b>(n=10)</b>	$\pm$ 2342.0*	$\pm$ 20.1	$\pm$ 78.1*		$\pm$ 100.4		

TW = total work; MP = mean power; PP = peak power; FI = fatigue index; W = watts. Values are means  $\pm$  SD. \*Significantly higher than Korea at the  $p < 0.05$ .

Table 3 shows the results of two groups from the isokinetic muscular functions of knee joints at 180°/sec. During isokinetic dynamometer tests at velocity 180°/sec, isokinetic strength and power output in knee extension were observed significantly ( $p < 0.05$ ) higher in Japan female collegiate wrestlers than in Korean female collegiate wrestlers, respectively. However, isokinetic dynamometer test at a velocity of 240°/sec, no significant differences were observed between two groups (Table 4.)

Table 3. Results of Isokinetic muscular function knee test in Korean and Japanese female wrestlers (180°/sec).

Group	180°/sec							
	LEP	REP	LEA	REA	LFP	RFP	LFA	RFA
<b>KOR</b>	116.5	109.5	208.7	193.7	66.7	64.2	128.3	123.8
<b>(n=6)</b>	$\pm$ 16.7	$\pm$ 14.3	$\pm$ 31.7	$\pm$ 34.8	$\pm$ 22.4	$\pm$ 18.4	$\pm$ 57.6	$\pm$ 37.0
<b>JAP</b>	125.9	132.2	228.3	230.1	68.5	72.6	135.7	146.9
<b>(n=10)</b>	$\pm$ 14.8	$\pm$ 14.9	$\pm$ 34.6	$\pm$ 24.6	$\pm$ 15.9	$\pm$ 24.9	$\pm$ 35.1	$\pm$ 50.3

LEP = left extension peak, REP = right extension peak, LEA = left extension average/repetition, REA = right extension average/repetition. LFP = left flexion peak, RFP = right flexion peak, LFA = left flexion average/repetition, RFA = right flexion average/repetition. Values are means  $\pm$  SD. \*Significantly higher than Korea at the  $p < 0.05$ .

Table 4. Results of Isokinetic muscular function knee test on TW in Korean and Japanese female wrestlers (240°/sec).

Group	240°/sec			
	LEP	REP	LFP	RFP
KOR(n=6)	2678.8±399.4	2604.7±248.1	1787.7±473.4	1676.3±404.7
JAP(n=10)	2751.2±314.7	2925.7±374.2	2096.7±436.8	1879.1±638.9

BW = body weight, LEP = left extension peak, REP = right extension peak, LFP = left flexion peak, RFP = right flexion peak. Values are means ± SD.

## DISCUSSION

### Anaerobic Exercise Capacity

Those who want to maximize wrestling match power, first of all, must have anaerobic capacity to display high-degree explosive skills. They must also possess muscular power or muscular endurance to master the competitors' resistances or attacks at the real wrestling matches and on the contrary to fight back the competitor (21). Anaerobic motion ability depends on the ability to supply ATP and PC, high energy compounds in humans. It's important in a match of where it is necessary to generate instant power or explosive power to execute technique in the course of a match.

This study measured an anaerobic exercise capacity, targeting female wrestlers' from Korea and Japan, and found that TW was 10935 J and 13914 J, observed significantly ( $p < 0.05$ ) higher in Japan wrestlers than in the Korean wrestlers.

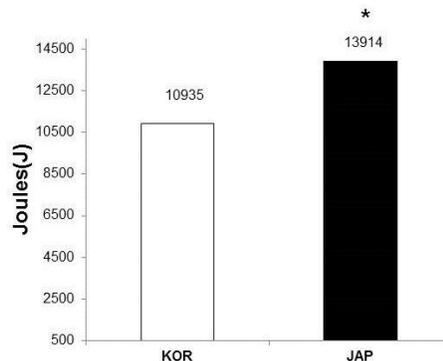


Figure 1. Between groups comparison of TW in WAnT. Values are Mean of Total Work. \* Significantly higher than Korea at the  $P < 0.05$ .

Korean female wrestlers' MP was 364.5 W and Japan female wrestlers' MP was 463.8 W. Japanese female wrestlers had a significantly higher MP ( $p < 0.05$ ).

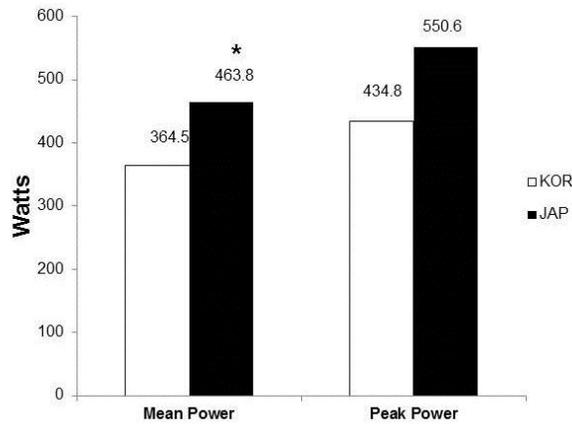


Figure 2. Between groups comparison of MP and PP in WAnT(W). Values are Mean of Mean Power and Peak Power in Watts. \*Significantly higher than Korea at the  $P < 0.05$ .

Korean and Japan female wrestlers' PP was 7.7 W. kg and 8.6 W. kg respectively, that significantly ( $p < 0.05$ ) higher in Japanese wrestlers than in Korean wrestlers ( $p < 0.05$ ).

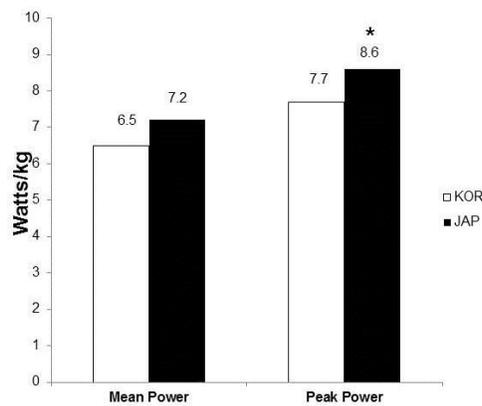


Figure 3. Between groups comparison of MP and PP in WAnT(W/kg). Values are Mean of Mean Power and Peak Power at W/kg. \*Significantly higher than Korea at the  $P < 0.05$ .

The results support the results from the 2004 Athens Olympics and the 2008 Beijing Olympics, where Japan earned 2 gold medalists, 1 silver medalist, and 1 bronze medalist, while Korea did not have any medalists.

There is a lack of study which takes a WAnT for 30 seconds, applying resistance load against similar aged persons, and targeting at female wrestlers (6,17). Turkish female youth wrestlers's MP are 279.9 W and 5.0 W. kg, absolute and relative values respectively, almost youth national players' levels, a step lower than Japan or Korean players' levels (17). Polish female national wrestlers' MP are 420 W and 6.8 W. kg, absolute and relative values respectively, and the PP are 530 W and 8.6 W, absolute and relative values respectively, lower than Japan players' values, but higher than Korean players'. After all, Korean female wrestlers' anaerobic exercise capacity is somewhat lower than reported for European wrestlers (6), but lower significantly than Japan wrestlers, who are at the top level in the world. The result verifies that in the future, Korean females must make their efforts to do special and creative physical training to enhance anaerobic exercise capacity, so that they can reach the top level.

### Isokinetic Muscular Function

Wrestling needs strong muscular strength of upper body and lower body to display a variety of skills (11), and have been shown to be associated with top wrestling performance (4). The value of muscular function measured with isokinetic measuring equipment could prove to be meaningful (19).

This study measured and compared isokinetic knee joint function at 180°/sec. When the Korean and Japanese wrestlers were compared, there was no significant difference in left knee extension, but right knee extensions of Korean female wrestlers and Japan wrestlers were 109.5 %BW and 132.2 %BW, respectively, a significant

difference. Korean female wrestlers' left knee extension power and Japan female wrestlers' left knee extension power were not significantly different, while their right knee extension powers had a significant difference.

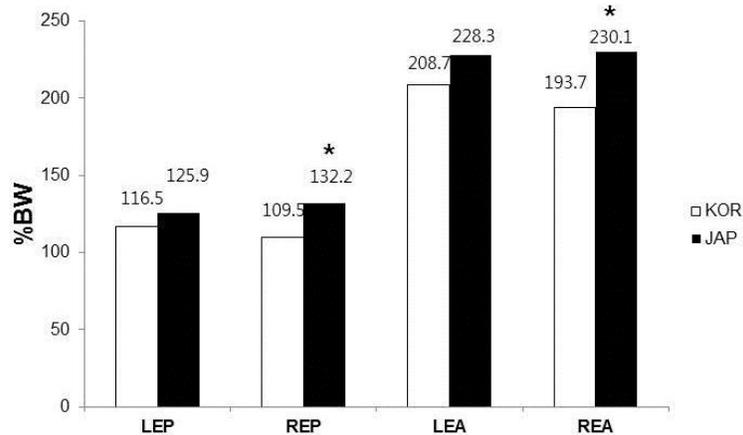


Figure 4. Between groups comparison of Isokinetic extension at 180°/sec. Values are Mean of right and left for Peak and Average/repetition Power. \*Significantly higher than Korea at the  $p < 0.05$ .

These strength differences can possibly explain some of the difference in international performance between wrestlers of the two countries.

There was no significant difference between left and right knee flexion of Korean and Japan female wrestlers. The results indicate that knee flexion has less of an effect on wrestling matches than knee extension in female wrestlers of the two countries. This has to be studied further, as well as the role of joint speed in regard to wrestling performance. The latter in light of the fact that Korean and Japan wrestlers didn't have a statistically significant difference in their isokinetic knee joint muscular functions at 240°/sec, and needs to be verified through further studies.

### PRACTICAL APPLICATIONS

The history of women's wrestling is relatively shorter than that of men's, and thus relevant information and data are not presently sufficient. The outcome of the study therefore is expected to play a helpful role in the improvement of female wrestler's performance and contribute to improved training.

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## **PERFORMANCE ANAÉROBIE ET FORCE ISOCINÉTIQUE CHEZ LES LUTTEUSES UNIVERSITAIRES CORÉENNES ET JAPONAISES**

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### **RÉSUMÉ**

Le but de cette étude était d'examiner et de comparer la performance anaérobie et la force isocinétique du genou chez des lutteuses universitaires coréennes et japonaises (n = 6, n = 10). Les variables du test incluaient la composition corporelle, le test de Wingate anaérobie (WAnT), et un test force isocinétique de la jambe. Ces données ont été utilisées pour diagnostiquer la capacité physique nécessaire des sujets pour être dans l'élite et pour comparer les données des deux pays. Les comparaisons entre ces données ont été calculées en utilisant la méthode du test t pour échantillons indépendants. Les résultats de cette étude étaient les suivants : WAnT, travail total (TW), la puissance moyenne (MP), et la puissance de crête (PP) ont été significativement (p < 0,05) plus faible chez les lutteuses universitaires coréennes. Au cours des essais au dynamomètre isocinétique à la seule vitesse de 180 ° / sec, la force isocinétique et la puissance de l'extension du genou droit ont été significativement plus faible chez les lutteuses universitaires coréennes (p < 0,05). En conclusion, ces résultats suggèrent que ces indicateurs peuvent être des déterminants de la performance des lutteuses. En outre, il semble que les lutteuses et leurs entraîneurs doivent prendre en compte les principes de la formation spécifique et individuelle pour l'amélioration de la capacité anaérobie et la force isocinétique.

**MOTS-CLÉS** : lutte féminine, performance anaérobie, force isocinétique, facteur de performance des lutteuses