

## Comparison of Isokinetic Muscular Strength of Knee according to Female Volleyball and Table Tennis Players

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**Abstract** The purpose of this study was to compare the isokinetic muscular strength of the knee joint between female volleyball and table tennis players. A total of 27 elite volleyball players and 27 table tennis players participated in the study. This study measured both knee extensor and flexor strengths of volleyball and table tennis players using the isokinetic dynamic test. Peak torque was measured by performing maximal voluntary flexion and extension three times at 60°/s. Volleyball players had higher knee extensor and flexor strengths than table tennis players. No significant difference in both knee strengths was noted in table tennis players. However, volleyball players showed significant differences in both knee strengths. Height and weight showed a positive correlation with knee strength. This study found that volleyball players had greater knee strength than that of table tennis players. We also found that volleyball players have asymmetrical knee strength. Comparison with other sport players is warranted to better understand isokinetic muscular strength of the knee joint.

**Key Words** : Table tennis player, Volleyball player, Knee, Flexor strength, Extensor strength, Elite Ball Game Athletes

요 약 본 연구의 목적은 여자 배구선수와 탁구 선수 사이에 무릎 관절의 등속성 근력 수준을 비교하는 것이다. 총 27명의 엘리트 배구 선수와 27명의 탁구 선수가 이 연구에 참여하였다. 본 연구는 등속성 근력 측정을 통해 여자 배구선수 및 탁구 선수 무릎 굽힘근 근력과 펴기근 근력의 양을 측정하였다. 최대 토크는 60°/s에서 3회 최대 수의적 굽힘과 펴기 수축을 수행하여 측정하였다. 여자 배구 선수는 여자 탁구선수 보다 무릎 펴기근 근력이 높았다. 탁구 선수들은 왼쪽과 오른쪽 무릎 근력에 유의한 차이가 없었다. 하지만 배구 선수들은 양쪽 무릎 근력에 차이를 보였다. 또한, 신장과 체중은 무릎 근력과 양의 상관관계를 보였다. 본 연구를 통해 여자 배구 선수는 탁구 선수보다 무릎 근력이 더욱 높은 수준에 있음을 알 수 있었다. 또한 배구 선수가 비대칭적 무릎 근력이 있음을 발견하였다. 향후 연구에서는 등속성 근력강도에 대한 연구가 다른 스포츠 선수와 비교하여 확인될 것을 기대한다.

주제어 : 탁구 선수, 배구 선수, 무릎, 굽힘 근력, 펴기 근력, 엘리트 구기종목 선수

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## 1. Introduction

### 1.1 Introduction

Korean athletes have been performing well in various international competitions as a result of the integration of modern science and efforts of elite players. Soccer, baseball, volleyball, table tennis, and basketball are particularly popular sports in Korea. Ball game players require movement of the lower extremity in multiple planes, requiring repeated flexion and extension motions of the knee joints [1]. As these players have to demonstrate the appropriate skills, high muscle strength and endurance are required for muscle contraction [2].

Most sport events require strength, speed, and skills. Volleyball is a game in which six players use a variety of skills to pass a ball to the opponent's court and score when the ball touches the floor [3]. Volleyball is a game in which fast movements, repeated jumps, and motion skills are needed. Volleyball players require leg power through the lumbar spine, which requires not only aerobic but also anaerobic ability [4]. Moreover, they require fast and high jump and exercise skills, along with ability to stably coordination movement [5].

Table tennis is a racket-based game, similar to tennis, badminton, or squash. Table tennis is a high-intensity sport with a maximum heart rate of 80% during the game [6]. Furthermore, due to sudden deceleration or fast acceleration in the limited space, changes in the direction are observed, so frequent damage to the shoulder and elbow joints occurs, and load is applied to the ankle, knee, hip, and even lower extremity [7]. The asymmetrical trunk rotation movements of the table tennis player can cause knee osteoarthritis by loading the supporting knee [8]. Therefore, knee muscle strength is required.

Unlike other ball games, table tennis is a sport suitable for the body shape of Korean individuals because it is relatively small in terms of

determining the win or loss in the game due to physical superiority [9]. Many sport scientists and leaders revealed that, in order to achieve the best performance, it is important to identify the necessary elements of physical strength according to the characteristics of the sport. For this purpose, the characteristics and physical strength required by athletes must be evaluated and developed [5]. In the table tennis, frequent changes in direction including rapid deceleration or acceleration, occur frequently in the lower extremities, resulting in damage to the ankle, knee, and thigh [7]. In the volley ball, quadriceps (knee extensors) and hamstring muscles (knee flexors) groups are involved in important motor ability such as running and jumping [9]. Moreover, volleyball players performed more jumps with higher muscle strength [10]. Therefore, this study was to compare the strength of knee joint (agonist / antagonist and dominant / non-dominant) according to sports.

Muscular strength is important component of sport. Muscle imbalance is one of the referred intrinsic factors in sports injury. One of the used methods to assess muscle strength balance between agonist/antagonist and dominant and non-dominant is isokinetic test [10]. Isokinetic testing is a commonly used tool for evaluating muscle strength in physical medicine settings and allows objective measurements [11].

Therefore, the purpose of present study was describe and compare the bilateral leg isokinetic strength of knee extensor and knee flexor in female volleyball and table tennis players.

## 2. METHODS

### 2.1 SUBJECTS

Female elite players were recruited from the national table tennis team (n=27) and the Incheon Heungkuk Life Insurance Pink Spiders women's volleyball team and Korea Ginseng Corporation Pro

Volleyball Club (n=27). The inclusion criterion of this study was the absence of any medical history. Prior to evaluation, the research details were fully explained. All players agreed to participate in this study. The participations were voluntary, and consent was obtained.

General characteristics of the all player are presented in Table 1. The G Power program was used in sample size calculation. Sample size was calculated as effect size 0.50, power 0.80, and alpha 0.05, using the medium effect size suggested by Cohen. A total of 27 table tennis players and 27 volleyball players were finally recruited.

Table 1. General characteristic of subjects

	Volleyball group (n=27)	Table tennis group (n=27)	P
Age (year)	26.44±3.86	26.04±4.50	.734
Height (cm)	178.28±6.11	164.48±4.51	.000
Weight (kg)	69.48±7.23	56.91±11.69	.000
Dominant leg	right 19, left 8	right 18, left 9	.588

Mean± Standard deviation

This study measured both knee extensor and flexor strengths of volleyball and table tennis players using the isokinetic dynamic test. The HUMAC (CSMI, USA) was used in the isokinetic dynamic test of knee strength. During the measurement, the chest, abdomen, and thigh areas were fixed to prevent compensation during knee joint flexion and extension. The lever arm was placed approximately 2 cm above the ankle joint. Peak torque was measured by performing maximal

voluntary flexion and extension three times at 60°/s [7]. All players were instructed to practice three times, and after 1-min rest, measurement was performed [12].

### 2.2 Statistical analysis

In this study, statistical analysis was performed with SPSS 20.0, and alpha was .05. The general characteristics of all players were confirmed by chi-squared test and independent t-test. The difference in knee strength between volleyball and table tennis players was determined by independent t-test. The difference between the left and right knee strengths of each study group was compared using a paired t-test. Correlation of height, weight and right, and left knee strength were analyzed by Pearson's correlation coefficient (Pearson's r).

## 3. RESULTS

### 3.1 RESULTS

#### 3.1.1 Comparison of muscle strength of both knee joint

Comparison of muscle strength of both knee joints is shown in Table 2. The knee flexor and extensor peak torque was significantly higher in the volleyball group than the table tennis group. The table tennis group showed no significant difference in left and right knee strengths. However, in the volleyball group, the left knee flexor peak torque was significantly higher than the right.

Table 2. Comparison of muscle strength of both knee joint

	Volleyball group (n=27)	Table tennis group (n=27)	t	p
Right knee extension strength (Nm)	181.66±38.88	142.15±23.36	-4.419	.000 <sup>2</sup>
Left knee extension strength (Nm)	181.29±24.02	145.12±21.34	-5.691	.000 <sup>2</sup>
	.957	.169		
Right knee flexion strength (Nm)	81.54±13.85	71.96±11.82	-2.661	.001 <sup>2</sup>
Left knee flexion strength (Nm)	85.77±14.32	72.23±11.61	-3.716	.001 <sup>2</sup>
	.031 <sup>1</sup>	.886		

<sup>1</sup>p < 0.05; <sup>2</sup>pairedttest,<sup>2</sup>Independentttest

### 3.1.2 Correlation of height, weight and Right, left knee strength

Correlation of height, weight and right, and left knee strength are shown in Table 3. Heights were moderately correlated with right flexor strength, left flexor strength, right extensor strength, left extensor strength, and .487, .557,

.670, and .664, respectively. Weights were moderately correlated with right flexor strength, left flexor strength, right extensor strength, left extensor strength, and .569, .626, .524, and .654, respectively.

Table 3. Correlation of height, weight and Right, left knee strength

	Right flexor Strength r(p)	Left flexor Strength r(p)	Right extensor strength r(p)	Left extensor strength r(p)
Height	.487(.000)	.557(.000)	.670(.000)	.664(.000)
Weight	.569(.000)	.626(.000)	.524(.000)	.645(.000)

## 4. DISCUSSION

This study was to compare isokinetic strength of flexion and extension of both knee joints of female volleyball and table tennis players and compare left and right muscle strengths of each player. Knee extensor and flexor strengths were significantly higher in the volleyball group than the table tennis group. Volleyball requires high jumps in spiking or blocking [4]. Elite volleyball players who jump a lot greatly need the velocity and force of the knee extension muscles [13]. Blocking skill is important for a power that jumps while the body is bent as much as possible [14]. Therefore, in the case of volleyball players, it seems that the strength of flexion and extension of the knee joint for leaping is more developed than those in other athletes.

In contrast, table tennis requires accurate physical performance because it uses a racket to hit the ball and is played using various directions, speeds, and rotations [15]. Table tennis players must move the center of the human body anteriorly while minimizing the lateral displacement to prevent dispersion of force during the game [9]. Therefore, high jump force is not required in table tennis. Due to the characteristics of each sport, a volleyball player has higher knee flexion and extension torque than a table tennis player.

However, since a volleyball player has higher

weight and height than a table tennis player, the difference in strength due to the weight of the volleyball player cannot be ruled out. The elite athletes who participated in this study showed that the higher the height, the stronger the knee strength and the same result was obtained in body weight.

Although the dominant leg of the volleyball player was on the right side, the left knee flexor strength was significantly higher than the right. Teixeira [16] compared knee flexor and extensor strengths between volleyball, handball, soccer, and basketball players and compared the differences in knee flexion [16]. Volleyball players showed no difference in both knee bending strengths [16]. The difference between this study and the previous study is considered to be the result of gender. In the previous study, male players were evaluated, but in this study, it was female volleyball players. Female volleyball players have a greater difference in leg mechanics during landing than male counterparts, resulting in greater knee injuries [17]. In elite volleyball players, knee injuries associated with spikes occur mainly when the legs are used for a long period [18]. When landing after a spike, deep knee flexion angles in the left knee may cause patellar tendinitis [19]. Muscle imbalance and weakness in volleyball players is a risk factor for injury [20]. The elite female volleyball player

who took part in the study did not show any difference in knee strength because of no injuries. It is possible that asymmetrical differences in knee flexor muscle strength due to repetitive jumping and landing movements, which are common in volleyball players, may have occurred. However, there may be a difference in knee strength due to unilateral movements such as spike and serve of volleyball players [21].

The limitation of this study is that it does not control the difference between the height and weight of volleyball player and table tennis player. And this study was conducted only for female volleyball and table tennis players in their twenties; therefore, it is necessary to be generalized to all ages. In this study, we did not determine injuries according to each sport. However, most previous studies have included male athletes, and similar research on female athletes is lacking. Thus, our study provides the much needed data on female athletes is lacking. Thus, our study provides the much needed data on female athletes. We believe that our results will serve as preliminary data that will fuel future studies to improve the performance of female athletes.

## 5. CONCLUSION

The present study aimed to compare the bilateral leg isokinetic strength of knee extensor and knee flexor in female volleyball and table tennis players. Volleyball players had higher strengths of knee extensors and flexors than table tennis players. And, in the volleyball group, there was a difference between dominant leg and non-dominant leg in knee flexors. Therefore, balance training of volleyball player's lower extremity is needed in future studies.

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