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The Effect of Different Warm up Protocols on Isokinetic Leg Strength in Female Taekwondo Athletes

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ABSTRACT
Performance in taekwondo sports depends on such factors as strength, speed, flexibility, technical as well as technical and tactical factors such as neuromuscular functions. This study was carried out to investigate the effect of different warm up methods and static stretching performed with warm up on the lower extremity isokinetic strength. Twenty-eight women taekwondo athletes (21.38 ± 1.88 years, 56.98 ± 7.19 kg, 1.67 ± 0.04 cm) participated in the study. Three different warm up protocols were applied to the subjects in the study. First one is 10 min. Jogging (A). Second is dynamic warm up (B). Lastly dynamic warm up and static stretching exercises were applied (C). The Bonferroni multiple comparison test was applied as a statistical method to compare the data obtained during the study. A statistically significant difference in the Q (Quadriceps) values between at least two warming protocols was observed in comparing the mean values of the participants H (Hamstring), Q and R (Ratio) after different warm up protocols [$F(2\text{-}81) = 5.56$, $p < 0.05$]. The effect size calculated as a result of the test ($\eta 2 = 0.12$) shows that this difference is at low level. Repeated-measures analyses of variance have been used as the statistical method in the conduction of the comparisons between the warm up protocols with the data attained from the study. It is seen that the most efficient method among the warm up protocols applied to the female taekwondo practitioners is static stretching combined with dynamic actions.

1. Introduction

The different warm up protocols used in warm up may show differences in each training and each sport branch. There are studies supporting the fact that the stretching exercises conducted by using static, dynamic or PNF (Proprioceptive Neuromuscular Facilitation) stretching techniques, have positive impacts on increasing the joint mobility [2,36] and may lead to a better performance [12, 26, 38]. Static or dynamic stretching applications could be conducted in different periods and intensities for the purpose of increasing the speed of neural transmission, preparing the muscles for loads and increasing the joint motility following the sub-maximal activities increasing the body temperature in the warm up routine [21]. In the conducted studies, the application of static stretching and dynamic warm up exercises has been a subject arousing interest by many researchers, trainers and sport experts.

Static stretching (SS) includes the slow straining of the target muscle or muscle groups up to the stretching point and keeping them in that position for a while [1]. It is used at the end of training sessions to improve and/or maintain flexibility. There are studies with the findings that static stretching increases the flexibility, decreases the risk of injury and increases performance [13]. However, some research indicates that SS may have detrimental effects on

explosive strength (i.e. vertical jump), maximum strength, speed, and agility if used before muscular activity including these biomotor abilities [18, 21]. To overcome the negative effects of SS, it has been recommended to replace SS with dynamic warm up in the warm up period. It is asserted by some researchers that the deliberate contractions to be made from a moderate level towards higher intensity such as dynamic warm up before the sportive performance activate the nerve-muscle function and may increase the power production and performance [2, 16, 29]. The dynamic warm up exercises are including the jumping and skipping on the lower and upper extremity. It has been asserted by the previous studies that the deliberate contraction to be made from a moderate level towards higher intensities such as dynamic warm up before the performance of an athletic activity activate the nerve-muscle function and the power production and performance will increase [4, 17, 29, 36, 38].

Although it could not be completely understood why the strength values effect following the stretching exercises, it is thought that it compresses the performance via the mechanical and neural factors The length of the tendon elongates due to its elastic property in the stretching application and the tendon which is more flexible causes the skeletal muscle to remain shorter for straining before reaching the optimal length. For this reason, it is assumed that in the strength measurements conducted after the static stretching exercises, the strength decreases because the muscle does not reach the optimal sarcomere length for straining [19,34]. It has been specified by the researchers that the decrease in the strength observed within 15 minutes following the stretching application occurs due to the deformation occurring depending on the straining in the muscle-tendon unity [27]. Other studies have however not found any impact [11, 22, 24]. The impacts of these different warm up protocols applied in different sporting branches drew the attention of the researchers. Taekwando, where performance depends on the neuromuscular functions such as strength, speed, flexibility and technique, typically applies traditional warm ups consists of two parts. In the first part, aerobic warm up (warm up by running or cycling) takes place and in the second part, static stretching takes place [18, 21]. It has been determined with the conducted studies that the warm up performed before the training is matched for the purpose of improving these properties, is very important [5,15,28].

Trainers would like to know the warm up protocol for best performance. It is considered that both dynamic warm up and static stretching may be efficient due to the fact that this warm up protocol consists of dynamic actions and flexibility which is important in taekwondo sport. The purpose of this study is to examine the impacts of three different warm up protocols on lower-extremity isokinetic strength.

2. Material and Methods

2.1. Study Design

The study has been conducted at the Gazi University Sport Sciences Faculty Laboratory. Participants were informed about the nature of the study and were also informed that participation was voluntary and that they could withdraw at any time. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Gazi University.

2.2. Study Participants

28 elite level female taekwondo practitioners participated in the study. Some participants even have won medals in the international tournaments. They were trained 2-4 h/day six times a week. Height, body weight, age and sport age values of experimental group were determined as 167,3 ±0.04 cm., 56.98±7.19 kg, 21.38±1.88 years and 5.43±1.38 years.

2.3. Measurement

2.3.1. Isokinetic measurement

Body mass (kg) (scale) and height (m) (stadiometer - Seca, Germany) of the subjects was determined. Five-repetitive measurements of isokinetic right leg quadriceps (Q), hamstring (H) and quadriceps/hamstring (R) strength ratios has been conducted with the con/con test in angular speed of 60 degrees/second with an isokinetic dynamometer (Isomed 2000/ Germany). Test has been carried out in a sitting position and the subjects were secured or strapped to the chair. They were instructed to hold on to the handles at both sides of the armchair during the test.

2.3.2. Warm up protocol

Three different warm up protocols were applied to each of the subjects (n=28) in the study with an interval of one day in between applications. Isokinetic measurements were taken right after each warm up protocol.

Firstly a 10-minute running (A) protocol was applied, which consisted of a sub-maximal level 10-minute treadmill (HpCosmos, Germany) run. Sub-maximal warm up protocol with 70% intensity according to the Karvenon method has been applied. The second protocol is the dynamic warm up (B). Warm up exercise (10 minutes) has been conducted in 10 dynamic types. Subjects have applied the warm up exercises in each dynamic type for 15 meters with the increasing intensities and they have repeated the same exercise again until the starting point after resting for 10 seconds. The third protocol consists of the combined dynamic actions and static stretching (C). In the combined protocol, warm up exercises in 10 different types for 10 minutes and 5 stretching techniques applied to the legs as 30 seconds of stretching/15 seconds of resting have been applied.

2.4. Statistical Analysis

Repeated-measures analyses of variance have been used as the statistical method in the conduction of the comparisons between the warm up protocols with the data attained from the study. Bonferroni multiple comparison test has been applied for the purpose of finding which groups the difference stems from. Average and standard deviation values have been interpreted as the definitive statistics. All the meaningful speeds (degrees per second) have been determined at $p< 0.05$ level.

3. Results

No statistically meaningful differences were observed in Q peak torque between at least two warm up protocols in the comparison of the H, Q peak torque and R values of the participant group following three different warm up protocols [$F_{(2-81)}=5.56$, $p<0.05$]. The magnitude of the impact ($\eta^2=0.12$) calculated as a result of the test shows that this difference is at low level (Table 1).

Table 1. The comparison of H, Q, R average values occurring as a result of different warm up methods

Parameters	Warm up Protocols	□	SS	F	P	Between The Groups
Hamstring Peak torque (Nm)	(A)	92.9	17.4	2.62	0.08	
	(B)	90.5	22.3			
	(C)	101.7	17.7			

Quadriceps Peak torque (Nm)	(A)	136.4	19	5.56	0.01	B-C*
	(B)	125.6	22.4			
	(C)	143.1	17.7			
Ratio %	(A)	70.4	12.1	0.26	0.78	
	(B)	72.7	13.5			
	(C)	70.9	11.1			

4. Discussion

The most striking result of this study in which different warm up methods have been applied is that static stretching applied together with the dynamic warm up by the taekwondo practitioners is more efficient on the isokinetic leg strength. In the study, statistically meaningful results could not be found although an improvement has occurred in the leg strength performance after low-intensity aerobic warm up (A) and dynamic warm up (B).

Many different warm up protocols conducted before sportive training or competition are used to decrease the risk of injure and improve performance. Within the direction of this purpose; when the recently conducted studies are examined, different warm up methods peculiar to the branches catch the attention. The clearest impact seen in most of these studies is that especially the dynamic warm up ways have positive impacts on the strength performance. It has been specified in the conducted studies that the deliberate contractions to be made from a moderate level towards higher intensity such as dynamic warm up activate the nerve-muscle function and may increase the power production and performance [29, 35]. Thompsen et.al. [31] have expressed that the use of dynamic exercises in warm up is more applicable for the jumping performance for the athletes due to its positive impact when compared to the bicycle and static stretching applications.

In the study conducted by Yamaguchi et.al. [35] with eighteen healthy males, they have applied dynamic warm up to a group and only the warm up with running has been applied to the other group and they have determined that the dynamic warm up applied before the isokinetic leg strength measurement is more efficient. As a result of the study conducted by Faigenbaum et.al. [14] in which the acute impacts of the different warm up protocols on fitness performances have been assessed, they have notified that the dynamic warm up applications have increased the strength performance.

In a previously conducted study, it is expressed that static stretching conducted together with dynamic warm up could be more efficient in the branches such as taekwondo in which both strength and flexibility are important [21]. It has been specified that the static stretching movements before the exercise decrease the risk of injure and provide a good performance improvement at the point of performing the techniques [10]. When the studies in which this warm up way is applied are assessed, it catches the attention that their impact on strength parameter has not been examined very much. When other parameters taking place in the studies and the impacts on the athletes in different ages and levels are examined, Ognjen et al. [23] have tested the flexibility and vertical jumping performance of 13-14 aged male children to whom dynamic warm up and static stretching protocol have been applied. It has been detected in this study that static stretching applied together with dynamic warm up provides positive impact on the vertical jumping performances of the children. In another study, Faigenbaum et al. [14] have found that dynamic warm up and combined static stretching applications positively affect the speed, medicine ball throwing and vertical jumping

performance. In the study conducted by Rutledge et al. [25] on the ice-hockey practitioners, it has been determined that static stretching conducted with dynamic warm up has increased the flexibility of the hockey players more. In the study conducted by Turan et al. [33] on the archers, it has been determined that static stretching conducted with dynamic warm up may positively affect the shooting performances of the archers.

In the conducted study; as different from other studies, three different protocols applied by the elite female taekwondo practitioners have been assessed. The most complicated one of these protocols is the joint application of dynamic warm up and static stretching. While its positive impacts on flexibility, jumping, speed and some strength performances catch the attention in other studies conducted with this warm up way, its impact specifically on the leg strength has been examined with this conducted study. Consequently; it could be seen that the best strength value could be reached on the leg strength parameter in the female taekwondo practitioners by dynamic warm up and static stretching when compared to the other two warm up ways.

In addition; when considered from different viewpoints, there are also studies specifying that static-dynamic warm up works do not affect the strength performance [24, 32]. In the study conducted by Torres et al. [32] they have examined whether the static stretching and dynamic warm up applied to the upper body have any acute impact on the upper body muscle strength and as a result, they have determined that it does not have any impact [32]. In another study, only the impact of the static stretching has been examined and it has been specified that 3-repetitive 30-second lasting static stretching has not affected the result of the isometric squat movement in which there are many joints, but it has negatively affected the strength produced as a result of the knee extension movement in which there is only a single joint [22]. While Maisetti et al. [19] have detected that ankle plantar flexion isokinetic strength has been negatively affected by the static stretching lasting for 15 seconds and consisting of 5 exercises made on the calf muscle group, they could not find any difference in the isometric strength value produced as a result of the dorsal flexion movement. As it could be seen in the studies, single application of static stretching may cause to negative impacts on the strength parameter.

In another study conducted as different from upper level athletes, it has been cited that the static stretching does not significantly affect the strength in the university students competing in different branches [36]. The level, age, branch etc. of the athlete may make difference in the occurring impacts and many warm up types. Moreover; despite all these reasons, while dynamic warm up method has positive impact on the performance in every work requiring high power, static stretching method has not affected the performance in some studies and has negatively affected the performance in some other studies. The mechanisms responsible for the acute decrease observed in the strength, power and speed performances after the static stretching applications have not still been certain. However; the researchers have tried to explain the acute negative impact of the static stretching on performance with the changes in the neuromuscular transmission and/or biomechanical properties of the muscle. In the studies conducted by Cramer et al. [8] they have examined the impact of the static stretching on the isometric strength and consequently, they have specified that static stretching decreases the peak strength. They have tried to explain that this result is basically dependent on the decrease in the elastic energy accumulation skill of the muscle-tendon unity.

Despite the negative impacts of static stretching on the strength, its positive impacts on the joint range of motion and flexibility are revealed in many studies [5,17,37]. When the criterion of performance is considered in the sport of taekwondo, it is known that as well as strength, the flexibility parameter also comes to the forefront. When the traditional warm up models are examined in taekwondo, it could be said that static stretching has an important place in the warm up routine [9, 18]. Manoel et al. [20] think that the use of dynamic warm up methods will be

cleverer for the purpose of terminating the negative impacts of static stretching on the acute muscle power and benefitting from the dynamic warm up for all the sport branches for the warm up routine. Also in this conducted study, dynamic warm up combination has been tried as an addition to the static stretching by leaving the traditional warm up in taekwondo. Consequently, it has been observed that this applied new combination may prevent the loss of performance in leg strength and cause to an increase. Therefore; different dynamic warm up protocols containing permanent and rhythmic movements among the warm up routines of the taekwondo practitioners are applied and it has been proven that these kinds of dynamic exercises improve the vertical jumping performance [38] and increase the leg extension power [10]. Dynamic warm up applications conducted together with the static stretching could be suggested for the purpose of terminating the negative impact of the static stretching on the acute strength and ensuring a better consistence.

5. Conclusions

Although there are many studies in which the impacts of different warm up methods on performance have been examined for the athletes in different ages, branches, genders and levels, it could be seen that the answer for the question of how different combinations will affect the performance is not completely clear yet. For this reason; in this study, the comparison of the impacts of three different warm up protocols have been conducted on the leg strengths of the female taekwondo practitioners with the idea that the works to be performed in different branches and performances may be beneficial for the trainers and athletes. In the conducted study, it catches the attention that the dynamic warm up applied to terminate the negative impacts of the static stretching applied for increasing the impact of flexibility in the defense sports such as especially taekwondo on the acute muscle strength may cause to a positive impact on the strength parameter.

Conflicts of Interest: The authors do not declare any conflicts of interest with this study.

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