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The Effect of the Isokinetic Shoulder Strength on the Phases of Speed

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Abstract

This study aimed to investigate the effect of the isokinetic shoulder strength on the phases of speed performance. The study included 45 male participants who were athletes or had a sports background. The mean age of the participants was 19.64±2.02 years, the mean height was 175.11±14.54 cm, the mean body weight was 68.44±5.96 kg, and the mean sports age was 5.40±3.90 years. In the study, data on the isokinetic shoulder strength and phases of speed were collected. A 100-meter sprint test was used to evaluate the phases of speed, and a Cybex Humac Norm 2004 device was used to determine the isokinetic shoulder strength. In light of the results obtained, left shoulder extension peak torque (left SEPT) and left shoulder flexion peak torque (left SFPT) values were found to affect all phases of speed except reaction speed, while right shoulder extension peak torque (right SEPT) values were found to affect only reaction speed and middle acceleration phase. Furthermore, right shoulder flexion peak torque (right SFPT) values were found to affect all speed phases except early acceleration and the transition phase. In general, the isokinetic shoulder strength was found to affect all phases of speed, with the highest effect level in the maximum speed and in the continuity phases of speed. In conclusion, the isokinetic shoulder strength is thought to have a significant effect on overall speed performance. The isokinetic shoulder strength has the most effect, especially in the maximum speed and speed continuity phases. Shoulder strength should be taken into consideration when organizing the training programs of athletes in all sports branches that include short- or long-distance speed performance.

Keywords: Speed, strength, isokinetic.

İzokinetik Omuz Kuvvetinin Süratin Evrelerine Etkisi

Özet

Bu çalışmanın amacı, izokinetik omuz kuvvetinin sürat performansının evreleri üzerindeki etkisini araştırmaktır. Araştırmaya sporcu ya da spor geçmişi olan 45 erkek katılımcı dahil edilmiştir. Katılımcıların yaşları ortalaması 19,64±2,02 yıl, boyları ortalaması 175,11±14,54 cm, vücut ağırlıkları ortalaması 68,44±5,96 kg ve spor yaşları ortalaması 5,40±3,90 yıl olarak tespit edilmiştir. Araştırmada izokinetik omuz kuvveti ve süratin evrelerine ilişkin veriler toplanmıştır. Süratin evrelerinin değerlendirilmesi için 100 m sprint testi ve izokinetik omuz kuvvetinin belirlenmesi için Cybex Humac Norm 2004 cihazı kullanılmıştır. Elde edilen bulgular neticesinde sol omuz ekstansiyon peak tork (Sol OEPT) ve sol omuz fleksiyon peak tork (sol OFPT) değerlerinin reaksiyon sürati hariç, süratin tüm evrelerini etkilediği görülürken, sağ omuz ekstansiyon peak tork (sağ OEPT) değerlerinin yalnızca reaksiyon sürati ve orta ivmelenme evresini etkilediği belirlenmiştir. Ayrıca sağ omuz fleksiyon peak tork (sağ OFPT) değerlerinin ise erken ivmelenme ve geçiş evresi dışındaki tüm sürat evrelerini etkilediği görülmüştür. İzokinetik omuz kuvvetinin genel olarak süratin tüm evrelerini etkilediği görülürken en yüksek etki düzeyinin maksimum hız ve süratte devamlılık evrelerinde olduğu tespit edilmiştir. Sonuç olarak, izokinetik omuz kuvvetinin genel sürat performansı üzerinde oldukça önemli bir etkiye sahip olduğu düşünülmektedir. İzokinetik omuz kuvveti özellikle maksimum hız ve süratte devamlılık aşamasında en fazla etkiye sahiptir. Kısa veya uzun mesafeli sürat performansını içerisinde bulunduran tüm spor branşlarında yer alan sporcuların, antrenman programları düzenlenirken omuz kuvveti göz önünde bulundurulmalıdır.

Anahtar Kelimeler: Sürat, kuvvet, izokinetik.

INTRODUCTION

Sprint is running a predetermined short distance (100 m - 400 m) in as short a time as possible (8, 20). An athlete's ability to move from one position to another with the maximum speed he/she can reach, to make a movement at the highest possible speed, and to move a part or all of the body at the highest speed is defined as speed (9). Sprint is determined by the ability to accelerate, the magnitude of maximal speed, and the ability to maintain speed against the onset of fatigue (7).

Sprinting is one of the most powerful forms of human movement. Understanding the individual biomechanical factors, kinematics, and kinetic variables that are most important for sprinting is important for improved performance. Athlete-specific analyses may provide detailed biomechanical feedback to a coach that can facilitate the development of specific technical training programs designed to improve sprint performance (2). Performance in sprint events is largely dependent on the athlete's ability to accelerate mass and produce a high running speed in the forward direction. In order to accomplish this, the neuromuscular system, specifically the body and lower limbs, generate strength, which is applied to the ground during the support phase of the running stride cycle, i.e., during the brief contact between the foot and the ground with each stride (19).

Sprint performance differs from maximal speed because sprint performance refers to the best time over a given distance, whereas maximal speed refers to the highest instantaneous speed an athlete can achieve. The ability to generate strength and speed become the fundamental parts from which an athlete's ability to accelerate begins (17, 27). The technical essence of sprint encompasses many aspects, including strength application characteristics, biomechanical concerns, and motor learning aspects. There is no doubt that technical elements play a very important role in sprint performance. The technical skills of athletes enable the modulation of their genetically inherited and developed physical abilities. Hence, by outlining a training plan that elevates the athlete's physiological state, a coach aims to provide greater physical capabilities so that the athlete can modulate their technical ability (15). Weyand et al. (26) linked the ability to run at high speed to the production of high amounts of vertical ground reaction strength per unit body weight and the available time needed. Ground reaction strength is defined in Newton's Third Law of Reaction as; “For every action there is an equal and opposite reaction”. That is, “every time the feet touch the ground, the ground generates an upward reaction strength (11). Ground reaction strength is measured in terms of vertical strength or horizontal strength. The vertical strength pushes the individual upwards. This is antagonistic to the horizontal strength pushing the individual further forward. In both cases, the greater the strength applied to the ground, the further the individual will move in that direction. During sprinting, both vertical strength and horizontal strength are required. However, it is preferred to limit the vertical strength and maximize the horizontal strength to allow the individual to cover the horizontal distance faster during sprinting (11). Therefore, this study aimed to examine the effect of the isokinetic shoulder strength on the phases of speed performance.

METHOD

This study was conducted to investigate the effect of the isokinetic shoulder strength on the phases of speed performance and included 45 male participants who were licensed athletes or had a sports background. The mean age of the participants was 19.64±2.02 years, the mean height was 175.11±14.54 cm, the mean body weight was 68.44±5.96 kg and the mean sports age was 5.40±3.90 years.

Ethical approval and institutional permission

This study was conducted in accordance with the decision of the ethics committee of Selçuk University, Faculty of Sports Sciences, Non-Interventional Clinical Research, dated 05.12.2022 and numbered 163. Additionally, all participants gave written informed consent to participate in this study after being informed about the procedures approved by the ethics committee and in accordance with the Declaration of Helsinki.

This study was produced from the doctoral thesis "Examination of the Phases of Speed in Terms of Strength, Anaerobic Endurance and Balance". Additionally, this research was supported by Selçuk University Scientific Research Projects Coordination with Project number 22212045.

Experimental Protocol

In the study, a 100-meter sprint test was used to evaluate the phases of speed, and a Cybex Humac Norm 2004 device was used to determine shoulder strength. Each test was performed for all participants on different days, at least 72 hours later, in the same environment and conditions. Before each test, the necessary information about the test was given to the participants by the researcher. Before all tests were applied, a test-specific warm-up program was applied. In addition, each test was applied to the participants twice and the best degree was evaluated.

The 100-meter Sprint Test

The 100-meter sprint was performed on the tartan track at the 15 Temmuz Stadium of Selçuk University. During the 100-meter sprint, times were measured with an 11-gate wireless photocell system. The photocells were placed at the start (0 m), 5 m, 15 m, 25 m, 35 m, 45 m, 55 m, 65 m, 75 m, 85 m, and finish (100 m) (8, 17).

Speed performance was evaluated by dividing into 5 phases:

- Reaction speed (0-5 m)
- Acceleration: Early acceleration (5-15 m)

  Middle acceleration (15-25 m)

  Late acceleration (25-35 m)
- Transition phase (35-45 m)
- Maximum speed (45-75 m)
- Continuity in speed (75-100 m) (8, 17).

An active warm-up program was applied to the participants for 15 minutes before the test. At the starting point (0 meters), the subject takes a linear static standing position with one knee in front and one behind, and starts running when ready. The time spent at each stage was recorded.

The Isokinetic Shoulder Strength Test

The isokinetic shoulder strength test was performed with an isokinetic dynamometer (Cybex, Humac Norm 2004) in the laboratory of Selçuk University, Faculty of Sport Sciences. Before the test, the participants warmed up with a bicycle ergometer (55-65 rpm) for 7 min, followed by stretching for 3 min. The isokinetic muscle strength of the upper extremities of the athletes was measured at an angular velocity of 60°/s. The isokinetic muscle strengths were measured in two different joint movements, the right and left shoulder flexion/extension. Following the preliminary information about the test, the anthropometric data were entered into the Cybex apparatus one by one, and the device was adjusted. The range of motion of the joint was determined by the computer by making a sample movement. After the trial measurements were taken, the test measurement values made in accordance with the determined protocol were transferred to the computer environment. The gravity effect, which may cause false results in the measurements made in these joint movements, is also canceled by the device (4, 5, 25).

In 5 repetitions of maximum contraction, shoulder extension and flexion torque values were obtained at a speed of 60°/s. 5 minutes of rest were given between shoulder changes (4, 5, 25). During the tests, participants received verbal encouragement in the form of motivating words to enhance their performance. The best values were also recorded during the exercise.

Statistical analysis

SPSS IBM 27 package program was used to organize and calculate the data. The data were summarized by giving the mean and standard deviations. The normal distribution of the data was tested by One-Sample Kolmogorov Smirnov test, and it was determined that the data showed a normal distribution. To ascertain the connection between the isokinetic shoulder strength and speed phases, a Pearson correlation test was used. The level of influence of the data acquired for the isokinetic shoulder strength on the speed phases was determined using a Linear Regression test. The data obtained in this study were tested at a 0.95 confidence interval.

FINDINGS

Table 1. Physical characteristics of the participants

Variables	Mean	Standard Deviation
Age (year)	19.64	2.02
Height (cm)	175.11	14.54
Weight (kg)	68.44	5.96
Sports Age (year)	5.40	3.90

Table 2. Times of the subjects participating in the research to pass the phases of speed

Variables	Mean	Standard Deviation
Reaction Speed (sec)	1.11	0.15
Early Acceleration (sec)	1.39	0.13
Middle Acceleration (sec)	1.19	0.11
Late Acceleration (sec)	1.16	0.12
Transition Phase (sec)	1.14	0.16
Maximum Speed (sec)	2.43	0.29
Continuity in Speed (sec)	1.83	0.22

When Table 2 is examined, it was found that the mean reaction speed of the subjects participating in the study was 1.11±0.15 sec, the mean of early acceleration was 1.39±0.13 sec, the mean of middle acceleration was 1.19±0.11 sec, the mean of late acceleration was 1.16±0.12 sec, the mean of the transition phase was 1.14±0.16 sec, the mean of maximum speed 2.43±0.29 sec, and the mean of continuity in speed was 1.83±0.22 sec.

Table 3. Shoulder peak torque values of the subjects participating in the research		
Variables	**Mean**	**Standard Deviation**
Left SEPT (Nm)	49.82	9.71
Left SFPT (Nm)	41.62	9.02
Right SEPT (Nm)	54.38	20.42
Right SFPT (Nm)	42.58	10.13

When Table 3 is examined, it was found that the mean of left SEPT of the subjects participating in the study was 49.82±9.71 Nm, the mean of left SFPT was 41.62±9.02 Nm, the mean of right SEPT was 54.38±20.42 Nm and the mean of right SFPT was 42.58±10.13 Nm.

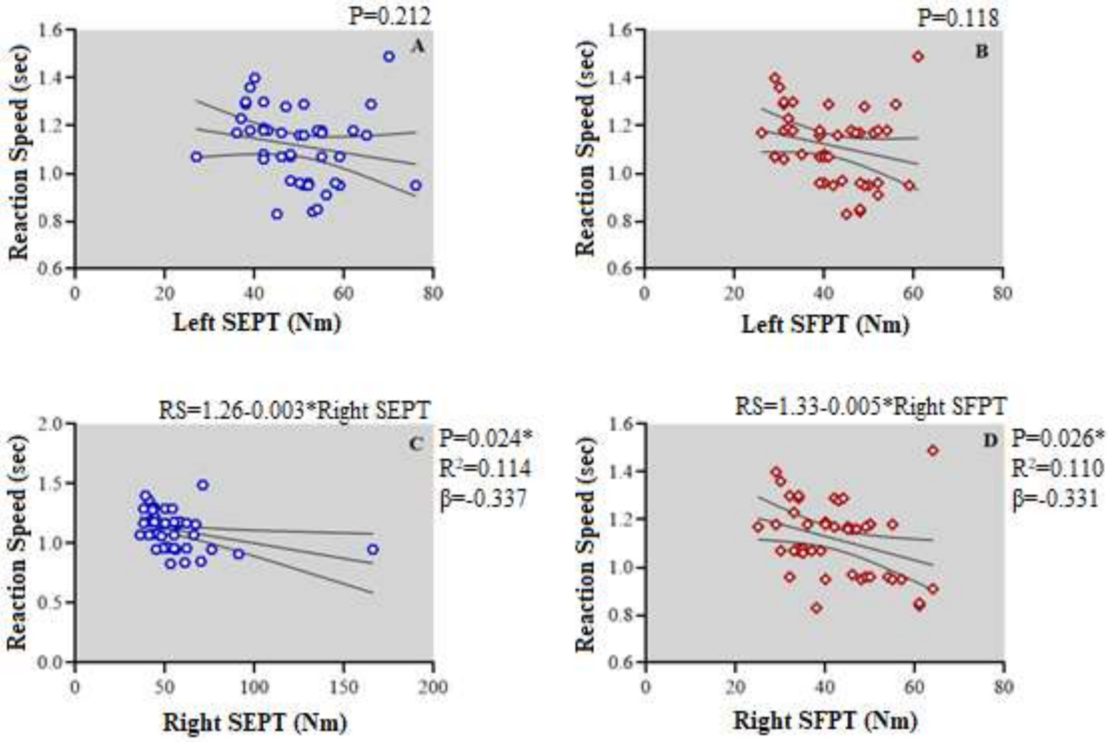

Figure 1. A: Relationship between reaction speed and left SEPT, B: Relationship between reaction speed and left SFPT, C: Relationship between reaction speed and right SEPT, D: Relationship between reaction speed and right SFPT.

Analyzing figure 1.A, it was determined that there was no significant relationship between reaction speed and the left SEPT of the subjects who participated in the study. It was observed that the change in the left SEPT values did not affect reaction speed ($P>0.05$). When figure 1.B was examined, it was determined that there was no significant relationship between reaction speed and the left SFPT of the subjects who participated in the study. It was observed that the change in the left SFPT values did not affect reaction speed ($P>0.05$). According to figure 1.C, it was determined that there was a significant relationship between the reaction speed of the subjects participating in the study and the right SEPT in the same direction ($P<0.05$). It was seen that the right SEPT value explained 11.4% of the reaction speed. A one-unit change in the right SEPT value affects reaction speed by 0.003. Figure 1.D shows that there is a significant relationship between the reaction speed and the right SFPT in the same direction ($P<0.05$). It was seen that the right SFPT value explained 11% of the reaction speed. A one-unit change in the right SFPT value affects the reaction speed by 0.005.

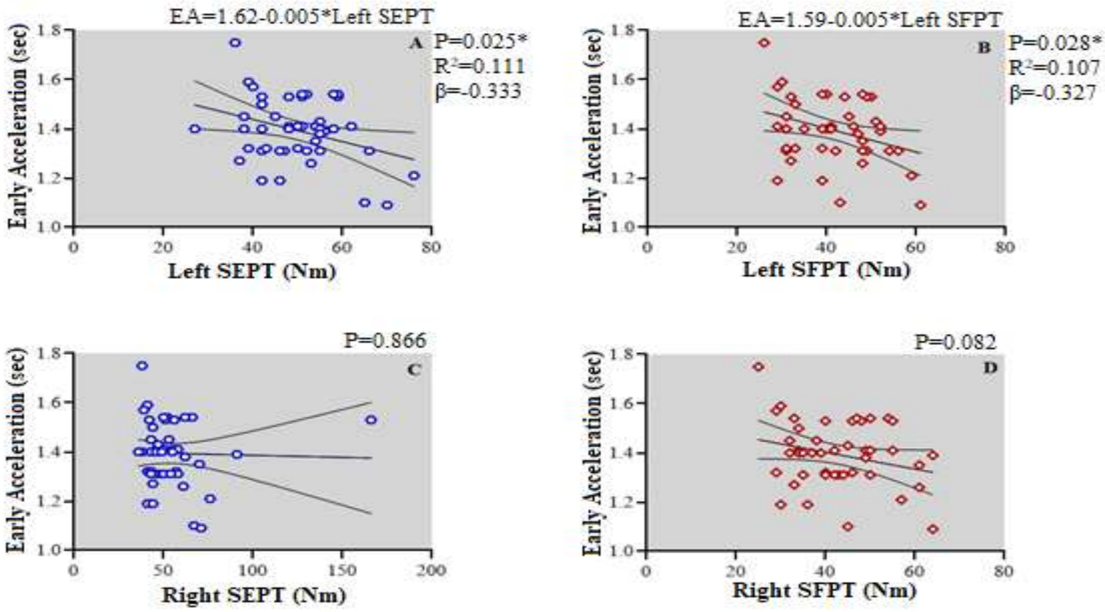

Figure 2. A: Relationship between early acceleration and left SEPT, B: Relationship between early acceleration and left SFPT, C: Relationship between early acceleration and right SEPT, D: Relationship between early acceleration and right SFPT.

As seen in figure 2.A, it was determined that there was a significant relationship between the early acceleration values of the subjects participating in the study and the the left SEPT in the same direction ($P<0.05$). It was observed that the left SEPT value explained 11.1% of the early acceleration. A one-unit change in the left SEPT value affects early acceleration by 0.005. According to figure 2.B, it was determined that there was a significant relationship between the early acceleration values of the subjects participating in the study and the left SFPT in the same direction ($P<0.05$). It was observed that the left SFPT value explained 10.7% of the early acceleration. A one-unit change in the left SFPT value affects early acceleration by 0.005. Analyzing figure 2.C, it was found that there was no significant relationship between the early acceleration values of the subjects participating in the study and the right SEPT values ($P>0.05$). It was observed that the change in the right SEPT values did not affect early acceleration. Figure 2.D shows that there was no significant relationship between the early acceleration values and the right SFPT values of the subjects who participated in the study ($P>0.05$). It was observed that the change in the right SFPT values did not affect early acceleration.

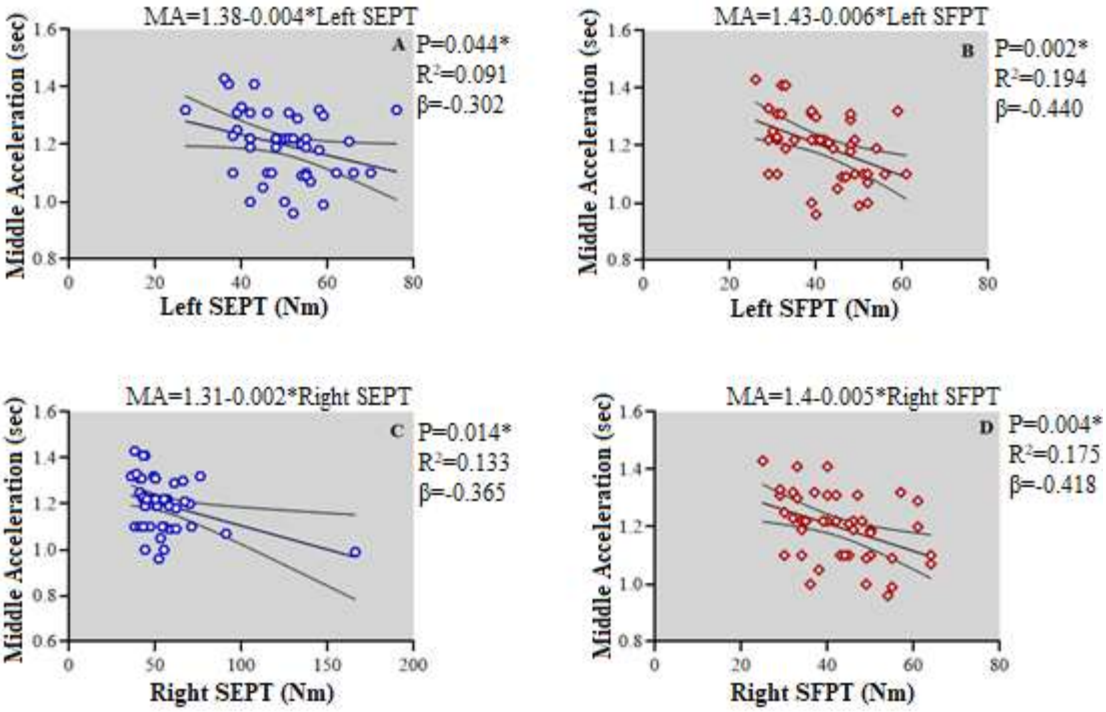

Figure 3. A: Relationship between middle acceleration and left SEPT, B: Relationship between middle acceleration and left SFPT, C: Relationship between middle acceleration and right SEPT, D: Relationship between middle acceleration and right SFPT,

As seen in figure 3.A, it was determined that there was a significant relationship between the middle acceleration values of the subjects participating in the study and the left SEPT in the same direction ($P<0.05$). It was observed that the left SEPT value explained 9.1% of the middle acceleration. A one-unit change in the left SEPT value affects middle acceleration by 0.004. When figure 3.B is analyzed, it is determined that there is a significant relationship between the middle acceleration values of the subjects participating in the study and the left SFPT in the same direction ($P<0.05$). It was observed that the left SFPT value explained 19.4% of the middle acceleration. A one-unit change in the left SFPT value affects the middle acceleration by 0.006. Analyzing figure 3.C, it was found that there was a significant relationship between the middle acceleration values of the subjects participating in the study and the right SEPT in the same direction ($P<0.05$). It was observed that the right SEPT value explained 13.3% of the middle acceleration. A one-unit change in the right SEPT value affects middle acceleration by 0.002. When figure 3.D is examined, it is determined that there is a significant relationship between the middle acceleration values of the subjects participating in the study and the right SFPT in the same direction ($P<0.05$). It was observed that the right SFPT value explained 17.5% of the middle acceleration. A one-unit change in the right SFPT value affects the middle acceleration by 0.005.

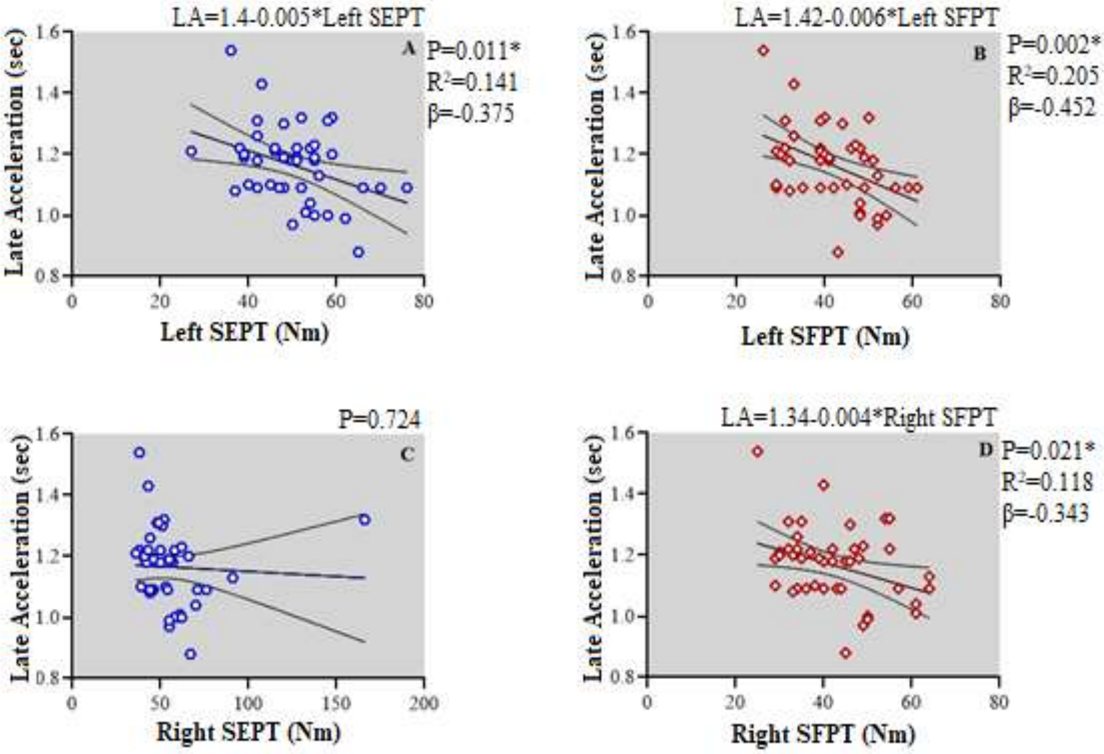

Figure 4. A: The relationship between late acceleration and left SEPT, B: The relationship between late acceleration and left SFPT, C: The relationship between late acceleration and right SEPT, D: The relationship between late acceleration and right SFPT.

When figure 4.A is analyzed, it was found that there was a significant relationship between the late acceleration values of the subjects participating in the study and the left SEPT in the same direction ($P<0.05$). It was observed that the left SEPT value explained 14.1% of the late acceleration. A one-unit change in the left SEPT value affects late acceleration by 0.005. According to figure 4.B, it was determined that there was a significant relationship between the late acceleration values of the subjects participating in the study and the left SFPT in the same direction ($P<0.05$). It was observed that the left SFPT value explained 20.5% of the late acceleration. A one-unit change in the left SFPT value affects late acceleration by 0.006. Analyzing figure 4.C, it was found that there was no significant relationship between the late acceleration values of the subjects participating in the study and the right SEPT ($P>0.05$). It was observed that the change in the right SEPT value did not affect the middle acceleration. Figure 4.D shows that there is a significant relationship between the late acceleration values of the subjects participating in the study and the right SFPT in the same direction ($P<0.05$). It was observed that the right SFPT value explained 11.8% of the late acceleration. A one-unit change in the right SFPT value affects late acceleration by 0.004.

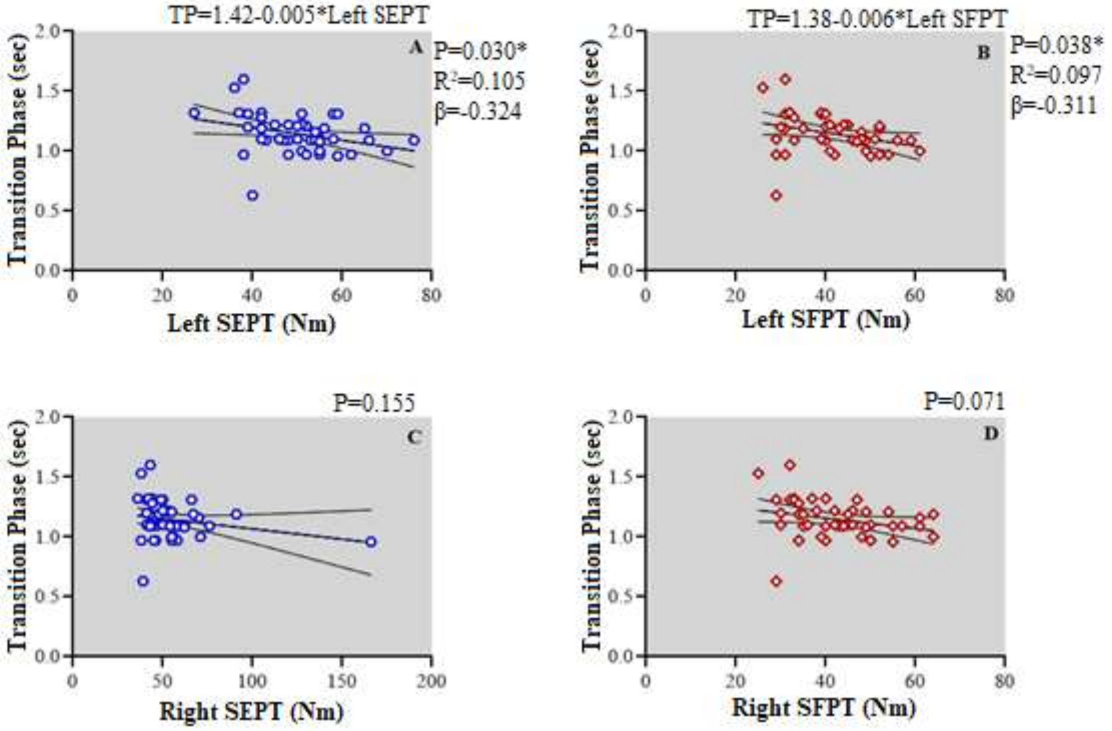

Figure 5. A: The relationship between the transition phase and the left SEPT, B: The relationship between the transition phase and the left SFPT, C: The relationship between the transition phase and the right SEPT, D: The relationship between the transition phase and the right SFPT.

Figure 5.A shows that there is a significant relationship between the transition phase values of the subjects participating in the study and the left SEPT in the same direction (P<0.05). It was seen that the left SEPT value explained the transition phase by 10.5%. A one-unit change in the left SEPT value affects the transition phase by 0.005. Figure 5.B shows that there is a significant relationship between the transition phase values of the subjects participating in the study and the left SFPT in the same direction (P<0.05). It was observed that the left SFPT value explained 9.7% of the transition phase. A one-unit change in the left SFPT value affects the transition phase by 0.006. An analysis of figure 5.C shows that there was no significant relationship between the transition phase values of the subjects who participated in the study and the right SFPT (P>0.05). It was observed that the change in the right SEPT did not affect the transition phase. According to figure 5.D, it was determined that there was no significant relationship between the transition phase values of the subjects participating in the study and the right SFPT (P>0.05). It was observed that the change in the right SFPT did not affect the transition phase.

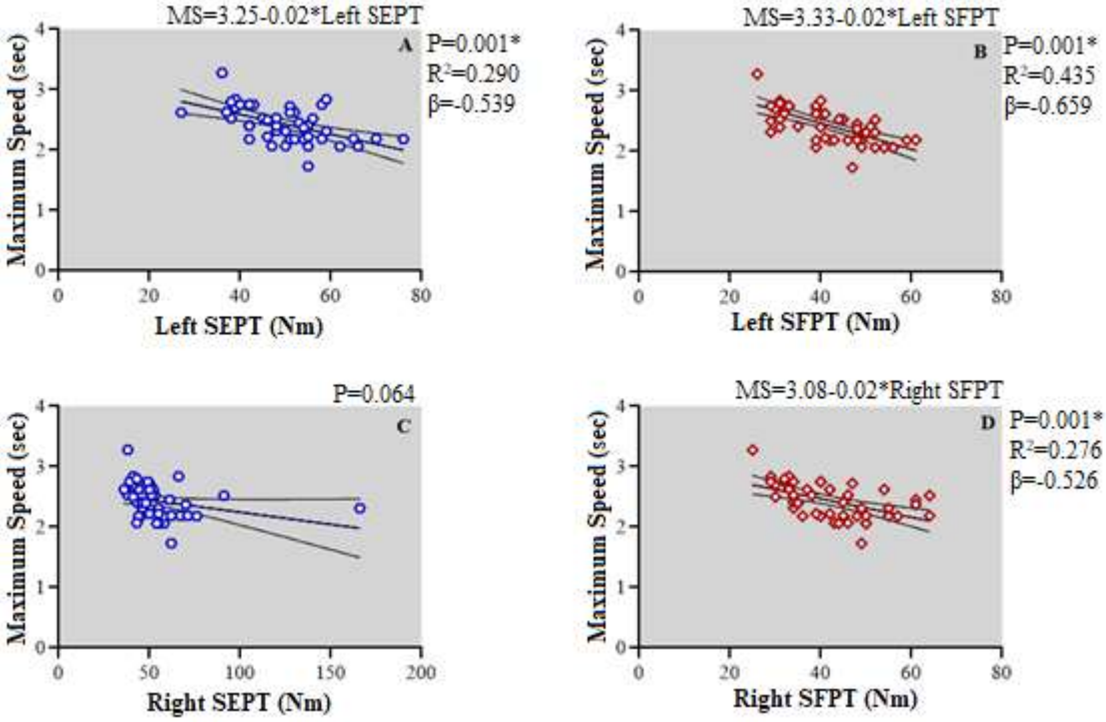

Figure 6. A: Relationship between maximum speed and left SEPT, B: Relationship between maximum speed and left SFPT, C: Relationship between maximum speed and right SEPT, D: Relationship between maximum speed and right SFPT.

Figure 6.A shows that there is a significant relationship between the maximum speed values of the subjects who participated in the study and the left SEPT in the same direction ($P<0.05$). It was observed that the left SEPT value explained 29% of the maximum speed. A one-unit change in the left SEPT value affects the maximum speed by 0.02. According to figure 6.B, it was found that there was a significant relationship between the maximum speed values of the subjects participating in the study and the left SFPT in the same direction ($P<0.05$). It was observed that the left SFPT value explained 43.5% of the maximum speed. A one-unit change in the left SFPT value affects the maximum speed by 0.02. Analyzing figure 6.C, it was found that there was no significant relationship between the maximum speed values of the subjects participating in the study and the right SEPT ($P>0.05$). It was observed that the change in the right SEPT did not affect the maximum speed. When figure 6.D was analyzed, it was determined that there was a significant relationship between the maximum speed values of the subjects participating in the study and the right SFPT in the same direction ($P<0.05$). It was observed that the right SFPT value explained 27.6% of the maximum speed. A one-unit change in the right SFPT value affects the maximum speed by 0.02.

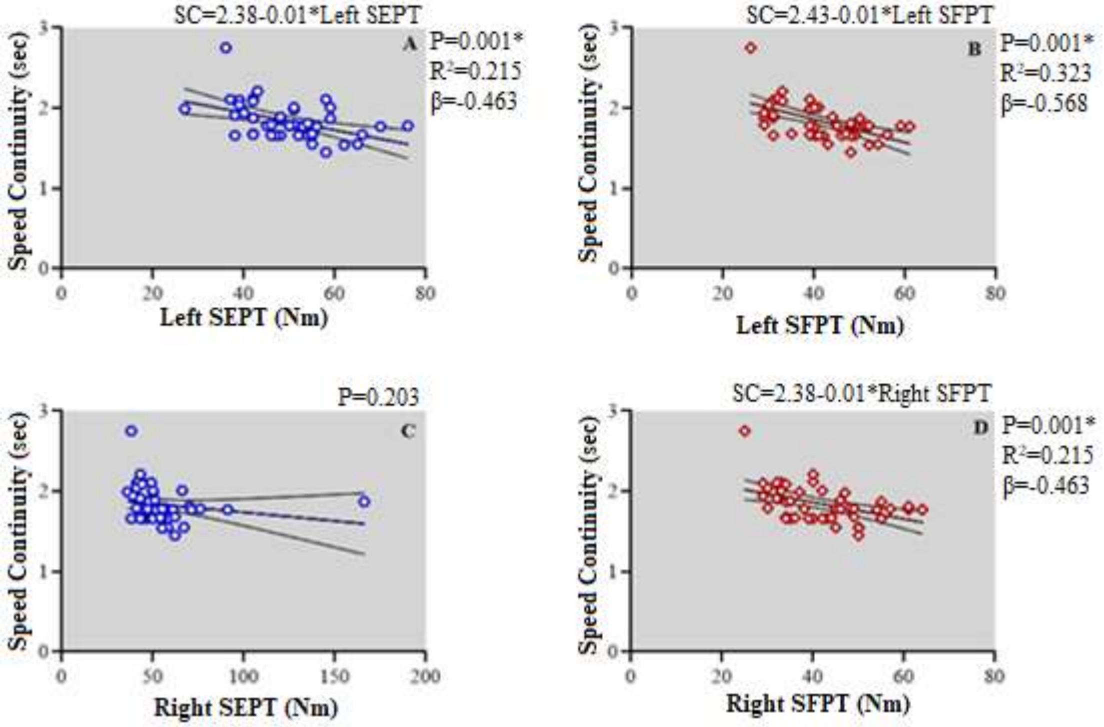

Figure 7. A: The relationship between continuity in speed and left SEPT, B: The relationship between continuity in speed and left SFPT, C: The relationship between continuity in speed and right SEPT, D: The relationship between continuity in speed and right SFPT.

Figure 7.A shows that there is a significant relationship between the speed continuity values of the subjects participating in the study and the left SEPT in the same direction (P<0.05). It was observed that the left SEPT value explained 21.5% of the speed continuity. A one-unit change in the left SFPT value affects speed continuity by 0.01. When figure 7.B was analyzed, it was determined that there was a significant relationship between the speed continuity values of the subjects participating in the study and the left SFPT in the same direction (P<0.05). It was observed that the left SFPT value explained 32.3% of the speed continuity. A one-unit change in the left SFPT value affects speed continuity by 0.01. Analyzing figure 7.C, it was determined that there was no significant relationship between the speed continuity values of the subjects who participated in the study and the right SEPT (P>0.05). It was observed that the change in the right SEPT did not affect the speed continuity. According to figure 7.D, it was determined that there was a significant relationship between the speed continuity values of the subjects participating in the study and the right SFPT in the same direction (P<0.05). It was seen that the right SFPT value explained 21.5% of the speed continuity. A one-unit change in the right SFPT value affects the speed continuity by 0.01.

DISCUSSION AND CONCLUSION

While there was no significant relationship between the left SEPT and reaction speed (Figure 1.A.), there was a significant relationship between the left SEPT and early acceleration (Figure 2.A.), middle acceleration (Figure 3.A.), late acceleration (Figure 4.A.), transition phase (Figure 5.A.), maximum speed (Figure 6.A.) and speed continuity (Figure 7.A.) No significant relationship was found between the left SFPT and reaction speed (Figure 1.B.), whereas there was a significant relationship in the same direction between the left SFPT and early acceleration (Figure 2.B.), middle acceleration (Figure 3.B.), late acceleration (Figure 4.B.), transition phase (Figure 5.B.), maximum speed (Figure 6.B.) and speed continuity (Figure 7.B.).

It was found that there was no significant relationship between the right SEPT and early acceleration (Figure 2.C.), late acceleration (Figure 4.C.), transition phase (Figure 5.C.), maximum speed (Figure 6.C.) and speed continuity (Figure 7.C.), while there was a significant relationship between the right SEPT and reaction speed (Figure 1.C.) and medium acceleration (Figure 3.C.). There was no significant relationship between the right SFPT and early acceleration (Figure 2.D.) and transition phase (Figure 5.D.), while there was a significant relationship between the right SFPT and reaction speed (Figure 1.D.), medium acceleration (Figure 3.D.), late acceleration (Figure 4.D.), maximum speed (Figure 6.D.) and speed continuity (Figure 7.D.).

In a study, it was found that shoulder extensor and flexor muscles, concentric and the eccentric isokinetic strength characteristics had a good significant relationship with 5 m and 25 m sprint performance, and knee flexors and extensors and some concentric muscle strength characteristics had a moderately significant relationship with 25 m sprint performance, while the eccentric strength characteristics of these muscles had weak relationships with sprint performance (10). Hermassi et al. (12) observed that weightlifting strength training for upper body development improved 15-meter sprint performance in handball players, while Ortega-Becerra et al. (21) reported that upper extremity strength plays an important role in jump and sprint capacity. Hori (13) examined the relationship between sprinter and nonsprinter participants' sprint performance and the isokinetic strength and reported that there was a difference in the level of relationship as the angular velocity increased. In a study conducted on different age categories, although there was no significant relationship between the isokinetic strength values and sprint performance of 15-year-old soccer players, significant relationships were found at different levels in the 16, 17, and 18 age groups (22). Ibret (14) found a negative relationship between the isokinetic strength parameters and 10 m, 20 m, and 30 m sprint performance. Some studies have reported that there is no significant relationship between maximal strength, reaction speed and acceleration performance (23, 18, 24). Chelly and Denis (6) stated that muscle power is needed to maintain acceleration and maximum speed in sprint performance. Majumbar and Robergs (16) stated that muscle power makes a greater contribution to the acceleration phase of sprinting. In the study of 61 athletes, the highest change in acceleration and speed was observed in the 9.1 m range. At the same time, it was determined that lower body strength affects especially the first acceleration (3). In his study, Anahtarcıoğlu (1) examined the effect of upper extremity isokinetic muscle strength on 30-meter sprint performance in elite amputee soccer players. He stated that shoulder flexor strength increased 30-meter sprint performance.

In conclusion, the isokinetic shoulder strength is thought to have a significant effect on overall speed performance. The isokinetic shoulder strength has the most effect, especially in the maximum speed and speed continuity phases. Shoulder strength should be taken into consideration when organizing the training programs of athletes in all sports branches that include short- or long-distance speed performance.

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