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The effect of elbow joint proprioception sense on shooting hit in basketball

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Abstract

This study aims to investigate the effect of proprioception on the shooting accuracy of male and female basketball players. In this study, 24 girls aged 13.58±2.43 years and 24 male athletes aged 14.80±1.03 years, who played basketball actively for at least 2 years, voluntarily participated. The target angle for the elbow joint was determined as 75° flexion movement. Joint position sense test method was used to measure elbow joint proprioception. Baseline 1° sensitive digital goniometer was used in the measurements. In the process of determining the amount of deviation, after 5 measurements were taken from an athlete, these 5 deviation values were av-eraged. When the average deviation value at the target angle of 75° was determined, this average deviation value was used in the comparisons. Male and female participants' total hits and deviation angles were examined, but no correlation was found ($p>0.05$). The total number of hits and deviation angle of male and female participants were examined, but no correlation was found ($p>0.05$). As a result, although there is no significant difference between the proprioception deviation angles of female and male basketball players, there is no relationship between the deviation angle and the shot hit.

Keywords: Elbow joint, motor control, proprioception, shooting accuracy, skill acquisition

Basketbolda dirsek eklemi propriyosepsiyon duyusunun şut atışına etkisi

Öz

Bu çalışmanın amacı, propriyosepsiyonun kadın ve erkek basketbolcuların şut isabetliliği üzerindeki etkisini araştırmaktır. Bu çalışmaya en az 2 yıl aktif olarak basketbol oynayan 13,58±2,43 yaşlarında 24 kadın ve 14,80±1,03 yaşında 24 erkek sporcu gönüllü olarak katılmıştır. Dirsek eklemi için hedef açı 75° fleksiyon hareketi olarak belirlendi. Dirsek eklemi propriyosepsiyonunu ölçmek için eklem pozisyon duyusu testi yöntemi kullanıldı. Ölçümlerde baseline 1° duyarlı dijital gonyometre kullanıldı. Sapma miktarının belirlenmesi sürecinde bir sporcudan 5 ölçüm alındıktan sonra bu 5 sapma değerinin ortalaması alındı. 75° hedef açıda ortalama sapma değeri belirlenirken karşılaştırmalarda bu ortalama sapma değeri kullanılmıştır. Erkek ve kadın katılımcıların toplam isabet ve sapma açıları incelendi ancak korelasyon bulunamadı (p>0,05). Kadın ve erkek katılımcıların toplam vuruş sayıları ve sapma açıları incelendi ancak korelasyon bulunamadı (p>0,05). Sonuç olarak kadın ve erkek basketbolcuların propriyosepsiyon sapma açıları arasında anlamlı bir fark bulunmamakla birlikte sapma açısı ile şut vuruşu arasında bir ilişki yoktur.

Anahtar Kelimeler: *Atış doğruluğu, dirsek eklemi, beceri edinme, motor kontrol, propriyosepsiyon*

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INTRODUCTION

Basketball is one of the most popular activities in the world and the main goal is to get a good shot to score a basket. Therefore, shooting is probably the most well-known basic skill in this game, and shooting well requires mainly correct movement of the upper extremity on the dominant side and also balance and jumping strength of the lower extremities (Krause et al., 1999). Strength is a necessary feature to be successful in many sports (Turgut, 2021).

Basketball is a sport that determines the results of the scores and the shooting skill point percentage, so the shooting skill to some extent determines the outcome of a basketball game. As a result, basketball players need to put a lot of effort into improving their shooting skills and do their best to prevent their opponents from scoring a basket in a match. It can be said that this situation plays a big role. Therefore, the shooting technique is one of the basic techniques in the basketball movement, the players in the game use more various techniques and tactics to shoot, score and create space. Although there are many factors such as mental state, shot selection and physical level that affect the score percentage, the main factor that determines the score percentage is the shooting technique. Specifically, it is hand movements, basket aiming points, whole body coordination, and index finger that determine whether the shooting technique is reasonable and the percentage of points. But regardless of changes in shooting techniques, the basis of any good shooting action and accuracy is correct and reasonable basic shooting technique. (Perkos et al., 2002; Button et al, 2003; Aybek et al., 2004; Dougherty et al., 2006; Zhen et al., 2015; Ceylan et al., 2022)

Proprioception, the ability to sense the position and movement of the body, plays a crucial role in motor control and movement coordination (Pekgöz-Çeviker, 2022; Ayhan, 2023). Through a complex network of sensory receptors, the brain is able to receive information about joint position, muscle length, and tension, which is used to plan and execute movements (Espí-López et al., 2021). Pressure senses, which are called deep senses, balance senses, vibration senses of tendons and muscles, position sense, body and extremity senses are the senses that govern the proprioceptive process. Deep senses are perceived by special sensors in the tissue known as mechanoreceptors and transmitted to the central nervous system. Deep sensory stimuli reaching the central nervous system create a response by bringing the joint to the safest position in order to produce the desired movement after various procedures (Kaynak et al., 2019; Oğul et al. 2022). There are two main components of the proprioceptive process. The first is to detect and analyze the motion perception by the central nervous system with mechanoreceptors, and the second is to create a response to bring

the joint into the correct position as a result of the analysis (Kaynak et al., 2019; Pérez-Silvestre et al., 2019). There are also factors that affect this proprioceptive process positively and negatively. It has been suggested that the use of elastic bandages, braces and knee braces, and various surgical interventions improve the sense of proprioception after injury (Forestier et al., 2002). It is explained that muscle fatigue adversely affects proprioception (Forestier et al., 2002). In addition to these, vestibular sense and visual sense also affect proprioception. Proprioception, which is the subject of many studies in the literature, is mostly mentioned in the recovery process after injury or with its preventive contributions (D'Amico et al., 2018). Proprioception is also supported through mental visualization and mental training (Çankaya et al., 2020). In addition to all these, proprioception also has an important place in our daily lives (Ayhan, 2022). Even during our simplest daily movements (sitting, walking, running, drinking water, getting up, etc.) with the help of the proprioceptive process, the central nervous system is informed and creates answers by analyzing the movements. Proprioception, which has an important place in our daily lives, is an even more necessary process in sports activities. Since the amount of load on the joints is higher in sportive activities compared to daily activities, the possibility of injury and injury may increase if the proprioceptive process is not functioning correctly and effectively (Zarandi & Asghar-Norasteh, 2015; Unal et al., 2017).

Proprioceptive feedback plays a necessary role in both learning new tasks and adjusting existing skills. Proprioception is particularly important for evaluating complex movements such as throwing basketball free throws (Fuentes & Bastian, 2010; Beets et al., 2012; Khlifa et al. 2012; Sevrez & Bourdin, 2015; Maglott et al., 2019). For example, situations such as a volleyball player's ability to spike or serve to the target area in the opposing team's court, a basketball player's successful three-pointer to the basket, and a football player's accurate pass can be indicators of good proprioceptive senses of the athletes (Akbuğa et al, 2020). Tropp & Gauffin (1992) attributed good proprioception and coordination to the ability of similar body structures such as joints to easily overcome overload, to the balance of the musculoskeletal system and to maintain joint stability. The fact that the proprioceptive senses are developed in young basketball players, especially between the ages of 11-16, will help basketball players to apply basketball techniques correctly in competitions. In this way, multifaceted gains can be achieved (Aybek & Aybek, 2023).

Considering that the sense of proprioception affects the shooting accuracy in basketball children, this study aims to examine the shooting accuracy by taking proprioception

measurement from the shoulder joint of male and female basketball players between the ages of 12 and 15 who can shoot basketball. It is thought that basketball players with a developed sense of proprioception can shoot more accurately.

The subject of the study, the problem, and the theoretical or conceptual framework of the research should be stated with their justifications, and an evaluation of the main sources should be made. The last paragraph of the introduction should state the purpose and original value of the study. Definitions, abbreviations, assumptions, and limitations, if any, should be presented in this section with their justifications.

METHOD

Research group (population-sample)

In this study, 24 girls aged 13.58±2.43 years and 24 male athletes aged 14.80±1.03 years, who played basketball actively for at least 2 years, voluntarily participated. The participants, who were randomly selected to represent the population of the basketball school in Samsun/Turkiye, were divided into two groups consisting of boys and girls. A random selection of male and female students was made from the list of athletes participating in the basketball school. The education level, age, or other characteristics of the selected students were also controlled, and the differences between the groups were minimized.

Pre-study application and evaluation methods were explained in detail to all individuals participating in the study. Informed consent for their voluntary participation was obtained from the athletes. Athletes who had undergone any elbow joint injury or surgery related to the elbow joint before the study were determined and excluded from the study.

Data collection/processing method

Measurements were made under standardized conditions for all participants in the study. The target angle for the elbow joint was determined as 60º flexion movement. Joint position sense test method was used to measure elbow joint proprioception (Beynnon, 2000; Grob et al., 2002; Akseki et al., 2010). This measurement method was previously preferred for a long time in the knee, shoulder, ankle and elbow joints, and its reproducibility and reliability were accepted (Marks, 1995; Jerosch et al., 1996).

Baseline 1° sensitive digital goniometer was used in the measurements. Before starting the measurement, the athletes were asked about the dominant arm and measurements were taken from the dominant arm. During the measurement, the athletes were asked to make a normal standing free throw. Standing trials were performed using the International Basketball

Federation regulations, with size 7 for men, 75–78 cm in circumference, and 567–650 grams in weight, and size 6 for women, 72–74 cm in circumference, and 510–567 grams in weight. The elbow joint and extremity to be measured were clearly seen by the researchers. The midpoint of the digital goniometer was fixed by holding it manually by placing the pivot point on the greater tubercle of the humeral bone for movement of the elbow joint. Tests were started when elbow joint measurement and goniometer value were at 0° angle. The angle to be tested was determined as 60°. Before the measurements were taken, the athletes were taught the target angle 3 times. In the teaching process, while the digital goniometer was fixed at the elbow joint, the individual was asked to raise his arm straight at the elbow without bending it. The person raised his arm straight without bending the elbow until he found the target angle and waited for 5 seconds when he found the target angle. Teaching the angle was applied 3 times and the target angle was taught. After the teaching process was completed, individuals were asked to find the target angle (60°) by themselves and measurements were made. When the individual actively flexed the elbow joint and brought his arm straight to the target angle of 60° without bending the elbow, he was asked to stop at this point. The angle value on the digital goniometer display was read and recorded as the first measurement result in the target angle that the individual learned beforehand and then found himself. In this way, teaching the target angle for each athlete was repeated 3 times and the measurement was repeated 5 times. In addition, individuals were rested sufficiently after finding the target angle (Sevrez & Bourdin, 2015). The amount of deviation from the taught angle in the measurements was recorded as a real value, whether it was positive (eg 68 degrees = +8° deviation angle in measurement) or negative (eg: 52 degrees = -8° deviation angle in measurement). In the process of determining the amount of deviation, after 5 measurements were taken from an athlete, these 5 deviation values were averaged. When the average deviation value at the target angle of 60° was determined, this average deviation value was used in the comparisons (Kaynak et al., 2019).

Data analysis

The normality distribution test of the data of the shot hit and the deviation angle was made using the Shapiro-Wilk test, and the Pearson Correlation was used to determine the relationship between the deviation angle and the shot hit on the data showing normal distribution, and the Independent Samples T Test was used to determine the difference between them. Independent Samples T Test was used to determine the difference between shooting hits by gender.

According to the Power analysis results: the size of the sample group to be used in the research should not be less than 48. This sample size is sufficient for a 0.05 error probability (α), 0.69 effect size (w), and 95% power (1-β). The noncentrality parameter is 19.99 and the critical value is 11.070. These results indicate that the sample was sufficient to detect the effect. The sample size is 46, and the true power of this sample is 0.95. This indicates that the sample is likely to detect the effect with 95% power.

FINDINGS

Study data were collected and descriptive analysis of participants was performed. Comparisons by gender were also made and the relationship between total hits and declination angle was sought.

Table 1. Descriptive data of participants (N=48)

Variables	x̄±Sd	Skewness	Kurtosis
Age	14.52±2.57		
Height(cm)	165.47±12.40		
Body Weight (kg)	54.76±14.43		
Age of Athlete (year)	3.44±2.12		
Total Hits	2.23±1.43	0.407	-0.623
Deviation Angle	7.29±5.20	1.274	1.177

Considering the descriptive data of the participants, the age of the participants was 13.52±2.57 years, height was 165.47±12.40 cm, body weight was 54.76±14.43 kg, age of the athletes was 3.44±2.12 years, total number of hits was 2.23±1.43, and deviation angle was 7.29±5.20.

Table 2. Comparison of number of hits and angle of deviation of participants by gender

Variables	Gender	x̄±Sd	t	p
Total Hit	Male	1.90±0.87	-1.105	0.278
	Female	2.37±1.61		
Angle of declination°(degrees)	Male	8.93±6.27	1.193	0.242
	Female	6.61±4.66		

There was no significant difference between male and female participants in the comparison of total hits and deviation angles according to gender (p>0.05).

Table 3 analyzed the relationship between total hits and declination angle of male and female participants in the study.

Table 3. The correlation between the number of hits and the angle of deviation of the participants

Variable	x̄±Sd	Declination angle
Total Hit	r	0.152
	p	0.391
	n	48

When the relationship between the total number of hits and the deviation angle of male and female participants was examined, no correlation was found (p>0.05).

Table 4 shows the relationship between the parameters Total Hit and Angle of Deviation of the male and female participants.

Table 4. The correlation of number of hits and angle of deviation of female and male participants

Variables		Angle of Deviation
Female Participants Total Hit	r	0.280
	p	0.185
	n	24
Male Participants Total Hit	r	-0.064
	p	0.861
	n	24

When examining the relationship between the total number of hits and the deviation angle of female and male participants, no correlation was found ($p>0.05$).

DISCUSSION AND CONCLUSION

In this study, it was aimed to investigate the relationship between the proprioception sense, deviation angle and shot hit values obtained from the elbow joint with 60^o, and the possible proprioception functional difference between the genders in male and female basketball players between the ages of 13-16. The age of the basketball players participating in the study was 2.80±1.03 years for boys and 3.70±2.40 years for girls. All participants' age was 3.44±2.12 years, height was 165.47±12.40 cm, and body weight was 54.76±14.43 kg. The total hit average of the participants in 5 free throws was 2.23+1.43 degrees, and the average deviation angle was 7.29+5.20 degrees (Table 1).

According to the results of this study, the average total hits in 5 free throws were found to be 1.90±0.87 in boys and 2.37±1.61 in girls, and the deviation angle was 8.93±6.27 in boys and 6.61±4 in girls. It was found to be 66 degrees. When mean free throws were compared by gender, no significant difference was found ($p>0.05$) (Table 2). According to the results of the study, it can be said that both shooting performance and deviation angle measurements of girls are better than boys. Especially in girls, shooting performance increased as the angle of deviation decreased. In men, the opposite is the case. As the deflection angle increased, the shooting performance decreased (Pekgöz-Çeviker & Şekeroğlu, 2022). An inverse proportion was found in both boys and girls. This result is expected. The fact that girls have better proprioception senses than boys may be due to the higher age of athletes in female participants. These results may reflect the interaction of many factors. Associations may not have been found, but further research and analysis may be needed to better understand these results. Akbuğa et al. (2020) conducted a study to examine the relationship between service accuracy and proprioception in adolescent female and male volleyball players aged 12-16, although the mean proprioception deviation angle of women was better than men at the end of

5 shots, the average of women's accuracy of service hits was less than that of men. found that it has value. Again, looking at the results in Akbuğa et al. (2020) studies, they stated that the expected situation is exactly the opposite. In the emergence of this situation, well-functioning proprioception sense (low deviation angle value) is expected to increase the accuracy of the serve throw. In other words, while an inverse ratio was expected between the two variables, a direct ratio was found. However, although there is a small difference between the means of the variables, this difference is not statistically significant ($p>0.05$). Kaya et al. (2012) found in their study on professional basketball players that there was a borderline tendency for significance between the percentage of free throws on the dominant side and the sense of position in the shoulder joint (eyes closed and at 160°). In the same study, they found a borderline significant correlation between the percentage of free throws on the dominant side and the sense of knee joint position (eyes open and 75°). However, they found no correlation between free throw percentage and shoulder joint position in 135◦ and 120◦ flexion. The fact that the correlation between proprioception and free throw success rate is moderately high for the wrist joint and only moderate for the elbow joint in the study they conducted by Sevrez and Bourdin (2015) supports the idea that proprioception can serve as a perceptual support for compensatory variability. On the other hand, Kabak et al. (2020), it was determined that the traction arm and grip arm, and the shoulder proprioception sense of men and women are similar to each other in archers. Studies comparing the sense of proprioception between genders are limited, and studies are generally related to the sense of proprioception in the knee and ankle joint after injuries (Payne et al., 1997; Dallinga et al., 2016; Sell and Lephart, 2018). In these studies, it is stated that men have a better sense of proprioception than women (Dallinga et al., 2016; Sell and Lephart, 2018). As a matter of fact, Kocahan et al. (2018) examined the shoulder proprioception sense of pistol shooters without any injuries and found that the proprioceptive senses of male and female shooters were similar (Kocahan et al., 2018).When the results of this study and the literature are evaluated together, while the results of this study are similar to some studies in the literature (Kocahan et al., 2018; Akbuğa et al., 2020; Kabak et al. 2020), different findings were found in some studies (Kaya et al., 2012; Sevrez & Bourdin, 2015). The emergence of different findings may be due to the fact that the basketball players participating in this study were young, had less experience in sports, and had different training and league levels.

The sense of proprioception can also be improved with the help of repetitive open and closed kinetic exercises (Safran et al., 2001; Kabak et al., 2020). With repetitive exercises,

neuromuscular control, muscle strength and kinesthesia sense increase. Thus, both the number of activated muscle spindles increases and the data input to the mechanoreceptors increases, and the sense of proprioception is also increased. (Safran et al., 2001; Dilek et al., 2016; Kabak et al. 2020). When the relationship between the total number of hits and the deviation angle of all participants in this study was examined, no correlation was found ($p>0.05$) (Table 3). When the relationship between the number of hits and the deviation angle by gender was examined, no correlation was found ($p>0.05$) (Table 4). Freeston et al. (2015) found no significant relationship between shoulder proprioception acuity and maximum or six-maximum (80%) speed throwing performance (speed or accuracy) in a group of elites, adolescent male baseball players. They attributed this reduction to cumulative microtrauma caused by repeated throws, possibly due to decreased function of the suprascapular nerve (this decrement to cumulative microtrauma resulting from repeated throwing, likely from reduced function of the suprascapular nerve) (Ferreti et al., 1998; Cummins et al. 1999; Freeston et al., 2015). When other studies on shooting accuracy and speed are examined, this study is compatible with the results of the study involving throwing in undergraduate students (Indermill and Husak, 1984), the study of cricket players of different gender, age and skill levels (Freeston et al., 2007; Freeston et al., 2008) and new (novice) (Van Den Tillaar & Ettema, 2006; Garcia et al., 2011) and the results of a study of elite European handball players (Van Den Tillaar & Ettema, 2003).

As a result, although there is no significant difference between the proprioception deviation angles of female and male basketball players, there is no relationship between the deviation angle and the shot hit. We can explain this situation by considering that free throw performance can be affected not only by the sense of proprioception, but also by many factors such as heart rate, anxiety and anxiety level, postural balance, hand grip strength, upper extremity muscle strength, and skill level. Regardless of the age group, training should definitely include proprioceptive exercises in order to improve the percentage of shooting accuracy. In addition, the scarcity of studies examining the proprioception and hit rate in the shoulder joint together draws attention in the literature. For this reason, more research will be required to clarify whether the sense of proprioception is a factor affecting sports success. The limitations of the study include the lack of a sufficiently large sample size and the inability to use more sensitive or reliable measurement tools.

GENİŞLETİLMİŞ ÖZET

GİRİŞ

Propriyosepsiyon, eklemin hareket algısını algılayıp, bu hareketi yorumlayan ve hareketi yerine getirecek uyarıya bilinçli ya da bilinçsiz olarak oluşturulmuş cevaplar olmakla birlikte bu süreç dâhilinde istenilen hareketler gerçekleşir (Akdoğan & Ertan, 2013; Yıldız, 2019; Espí-López ve ark., 2021). Günlük yaşamımızda önemli bir yer edinen propriyosepsiyon sportif faaliyetlerde daha da gerekli bir süreçtir (Yıldız, 2019). Sportif aktivitelerde günlük aktivitelere kıyasla eklemlere binen yük miktarı daha fazla olduğundan propriyoseptif süreç doğru ve etkili bir şekilde işlemediği takdirde sakatlanma ve yaralanma olasılıkları artabilmektedir (Zarandi & Asghar -Norasteh, 2015; Unal ve ark., 2017)

Propriyosepsiyonun ve koordinasyonun iyi olmasını, eklemler gibi benzer vücut yapılarının aşırı yüklenmenin kolayca üstesinden gelebilmesine, kas-iskelet sisteminin denge içerisinde olmasına ve eklem stabilitesini sürdürebilmesine bağlamışlardır. Küçük yaştaki özellikle 11-16 yaş arasındaki basketbolcularda propriyoseptif duyularının gelişmiş olması basketbolcuların müsabakalarda basketbol tekniklerini doğru bir şekilde uygulamasına yardımcı olacaktır. Basketbolcu çocuklarda propriyosepsiyon duyusunun basketbolda atış isabetini etkilediğini düşünürsek, bu çalışmada 13-16 yaş arası basketbol atışı yapabilen kız ve erkek voleybolcuların omuz ekleminden propriyosepsiyon ölçümü alınarak atış isabeti ile aralarındaki ilişkiyi incelemeyi amaçlamaktadır. Propriyosepsiyon duyusunun gelişmiş olduğu basketbolcuların daha isabetli şut atabilecekleri düşünülmektedir.

YÖNTEM

Bu çalışmada en az 2 yıl süreyle aktif olarak basketbol oynayan yaşı 13,58±2,43 yıl olan 24 kız ve yaşı 14,80±1,03 yıl olan 24 erkek sporcu gönüllü olarak katıldı. Çalışmaya katılan tüm bireylere çalışma öncesi uygulama ve değerlendirme yöntemleri ayrıntılı olarak açıklanmıştır. Sporculardan gönüllü katılımları ile ilgili aydınlanmış onamları alınmıştır. Çalışma öncesinde herhangi bir dirsek eklemi yaralanması veya dirsek eklemi ile ilgili cerrahi operasyon geçirmiş sporcular belirlenerek çalışmaya dâhil edilmedi.

Ölçümlerde Baseline 1° duyarlı dijital gonyometre kullanılmıştır. Ölçüme başlamadan önce sporculara dominant kolu sorulmuş ve dominant koldan ölçümler alınmıştır. Ölçüm sırasında sporculardan oturur pozisyonda, herhangi bir yere yaslanmadan, dik durmaları ve gözlerini kapatmaları istenildi. Ölçümü gerçekleştirilecek dirsek eklemi ve ekstremitenin araştırmacılar tarafından açık bir şekilde görülmesi sağlandı. Dijital gonyometrenin orta noktası, dirsek ekleminin hareketi için pivot noktası humerus kemiğinin büyük tüberkülüne yerleştirilerek el ile tutularak sabitlendi. Dirsek eklemi ölçümü, gonyometre değeri 0°'lik açıdayken testlere başlanıldı. Test yapılacak açı 60° olarak belirlendi. Sporculara ölçümler gerçekleştirilmeden önce hedef açı 3'er kez gözleri açık olarak öğretildi. Öğretme işleminde, dijital gonyometre dirsek ekleminde sabitken,

bireyden kolunu dirsekten bükmeden düz bir şekilde kaldırması istenildi. Kişi hedef açıyı buluncaya kadar kolunu dirsekten bükmeden düz olacak şekilde kaldırdı ve hedef açıyı bulduğunda 5 sn. bekledi. Açıyı öğretme işlemi 3 kez uygulandı ve hedef açı öğretildi. Öğretme işlemi bittikten sonra bireylerden hedef açıyı (60°'lik) kendilerinin bulması istendi ve ölçümler yapıldı. Birey aktif bir şekilde dirsek ekleminde fleksiyon yaparak 60°'lik hedef açı olarak algıladığı yere kolunu dirsekten bükmeden düz bir şekilde getirdiğinde bu noktada durması istendi. Bireyin önceden öğrenip sonra kendisinin bulduğu hedef açıda, dijital gonyometre göstergesindeki açı değeri okunup 1. ölçüm sonucu olarak kaydedildi. Bu şekilde her sporcuda hedef açıyı öğretme işlemi 3 kez, ölçüm ise 5 kez tekrarlandı. Ayrıca bireyler hedef açıyı bulduktan sonra mutlaka dinlendirildi (Sevrez & Bourdin, 2015). Ölçümlerde öğretilen açıdan sapma miktarı ister pozitif (ör: ölçümde 68 derece= +8° sapma açısı) ister negatif (ör: ölçümde 52 derece= -8° sapma açısı) değerler olsun reel değer olarak kaydedildi. Sapma miktarını belirleme işlemi, bir sporcudan 5 ölçüm alındıktan sonra bu 5 sapma değerinin ortalaması alındı. 60°'lik hedef açıdaki ortalama sapma değeri belirlendiğinde yapılan karşılaştırmalarda bu ortalama sapma değeri kullanıldı (Kaynak ve ark., 2019; Yıldız, 2019).

Şut isabeti ve sapma açısına ait verilerin normallik dağılım sınanması Shapiro-Wilk testi kullanılarak yapılmış normal dağılım gösteren verilere sapma açısı ve şut isabeti arasındaki ilişkiyi belirlemek için Pearson Korelasyonu ve arasındaki farkı belirlemek için bağımsız gruplar t testi kullanılmıştır. Cinsiyete göre şut isabeti arasındaki farkı belirlemek için ise bağımsız gruplar t testi kullanılmıştır.

BULGULAR

Bu çalışmada 13-16 yaş arasında kız ve erkek basketbolcularda, dirsek ekleminden 60o ile elde edilen propriyosepsiyon duyusunun, sapma açısı ve şut isabeti değerleri arasındaki ilişki ile cinsiyetler arasında olası propriyosepsiyon işlevsel farklılığın incelenmesi amaçlanmıştır. Katılımcıların 5 serbest atışta toplam isabet ortalaması 2,23+1,43, ortalama sapma açısı ise 7,29+5,20 derece olarak saptanmıştır (Tablo 1). Katılımcıların cinsiyete göre toplam isabet sayıları ve sapma açılarının karşılaştırılmasında erkek ve kız katılımcılar arasında anlamlı fark bulunmamıştır ($p>0,05$). Erkek ve kız katılımcıların toplam isabet sayısı ve sapma açısı arasında ilişkiye bakıldığında korelasyon bulunmamıştır ($p>0,05$). Kız ve erkek katılımcıların toplam isabet sayısı ve sapma açısı arasında ilişkiye bakıldığında korelasyon bulunmamıştır ($p>0,05$). Bu çalışmanın sonuçlarına göre 5 serbest atışta toplam isabet ortalamaları erkeklerde 1,90±0,87, kızlarda ise 2,37±1,61 olarak bulunmuş, sapma açısı ise erkeklerde 8,93±6,27 kızlarda ise 6,61±4,66 derece olarak bulunmuştur. Cinsiyete göre serbest atış ortalamalarını karşılaştırıldığında anlamlı fark ortaya çıkmamıştır ($p>0,05$) (Tablo 2).

TARTIŞMA VE SONUÇ

Çalışma sonucuna göre kızların hem atış performansı hem de sapma açısı ölçümlerinin erkeklere göre daha iyi olduğu söylenebilir. Özellikle kızlarda sapma açısı düştükçe atış performansı

yükselmiştir. Erkeklerde ise tam tersi bir durum vardır. Sapma açısı yükseldikçe atış performansı düşmüştür. Hem erkeklerde hem kızlarda ters orantı bulunmuştur. Bu sonuç beklenen durumdur. Kızların propriosepsiyon duyularının erkeklerden daha iyi olması kız katılımcıların sporcu yaşının daha yüksek olmasından kaynaklanabilir. Akbuğa ve arkadaşları (2020), 12-16 yaş aralığında adölesan kadın ve erkek voleybolcularda servis isabeti ve propriyosepsiyon arasındaki ilişkiyi incelemek amacıyla yaptıkları çalışmada 5 atış sonunda kadınların propriyosepsiyon sapma açısı ortalamasının erkeklerden daha iyi olmasına rağmen, kadınların isabetli servis atışı sayı ortalamasının erkeklerden daha az isabet değerine sahip olduğunu bulmuşlardır

Kaya ve arkadaşlarının (2012) profesyonel basketbolcular üzerine yaptıkları çalışmada dominant tarafta serbest atış yüzdesi ile omuz eklemi pozisyon hissi (gözler kapalı ve 160°'de) arasında anlamlılığa yönelik sınırda bir eğilim olduğunu bulmuşlardır. Yine aynı çalışmada dominant tarafta serbest atış yüzdesi ile diz eklemi pozisyon hissi (gözler açık ve 75°) arasında sınırda anlamlı bir korelasyon saptamışlardır. Ancak 135° ve 120° flexionda serbest atış yüzdesi ve omuz eklemi pozisyonunda korelasyon saptamamışlardır. Sevrez ve Bourdin (2015) yaptıkları araştırmada propriosepsiyon ve serbest atış başarı oranı arasındaki korelasyonun bilek eklemi için orta derecede yüksek, dirsek eklemi için ise sadece orta olması, propriyosepsiyonun telafi edici değişkenlik için algısal bir destek olarak hizmet edebileceği fikrini desteklemektedirler. Kabak ve arkadaşları (2020), çalışmasında okçularda çekiş kolu ile tutuş kolunun ve kadın ile erkeklerin omuz propriosepsiyon duyusunun birbirine benzer olduğu belirlendi. Cinsiyetler arasında propriyosepsiyon duyusunu karşılaştıran çalışmalar sınırlı olup, yapılan çalışmalar genellikle yaralanmalardan sonra diz ve ayak bileği eklemi propriyosepsiyon duyusu ile ilgilidir (Payne ve ark., 1997; Dallinga ve ark., 2016; Sell & Lephart, 2018). Bu çalışmalarda da erkeklerin propriyosepsiyon duyusunun kadınlara göre daha iyi olduğu belirtilmektedir (Dallinga ve ark., 2016; Sell & Lephart, 2018). Nitekim Kocahan ve arkadaşları (2018) herhangi bir yaralanması olmayan tabanca atıcılarının omuz propriosepsiyon duyusunu inceledikleri araştırmada kadın ve erkek atıcıların proprioseptif duyularının benzer olduğunu bulmuşlardır (Kocahan ve ark., 2018). Bu çalışmanın sonuçları ile literatür birlikte değerlendirildiğinde, bu çalışmanın sonuçlarının literatürdeki bazı çalışmalarla benzer iken (Kocahan ve ark., 2018; Akbuğa ve ark., 2020; Kabak ve ark., 2020), bazı çalışmalarda farklı bulgulara rastlanmıştır (Kaya ve ark., 2012; Sevrez & Bourdin, 2015). Farklı bulguların ortaya çıkması bu çalışmaya katılan basketbolcuların yaşlarının küçük, spor deneyiminin az, antrenman ve lig seviyelerinin farklı olmasından kaynaklanabilir.

Sonuç olarak, kız ve erkek voleybolcuların propriyosepsiyon sapma açıları arasında anlamlı bir fark olmamakla birlikte sapma açısı ve şut isabeti arasında bir ilişki de bulunamamıştır. Bu durumu, serbest atışı performansını sadece propriosepsiyon duyusundan değil, kalp atım hızı, kaygı ve anksiyete düzeyi, postural denge, el kavrama kuvveti, üst

ekstremite kas kuvveti, beceri düzeyi gibi faktörlerin birçoğundan da etkileyebileceği düşünerek açıklayabiliriz. Hangi yaş grubunda olursa olsun atış isabet yüzdesini geliştirmek için antrenmanlar mutlaka proprioseptif egzersizler içermelidir. Ayrıca literatürde omuz ekleminde propriyosepsiyon ve isabet oranını birlikte inceleyen çalışmalar azlığı dikkat çekmektedir. Bu sebeple propriosepsiyon duyusunun spor başarısını etkileyen bir faktör olup olmadığını netleştirmek için daha fazla araştırma yapılması gerekecektir.

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Fikir ve Kavramsal Örgü *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak *Form the research hypothesis or idea*	Hamza KÜÇÜK Fatih KARAKAŞ
Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Hamza KÜÇÜK Fatih KARAKAŞ
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Hamza KÜÇÜK Fatih KARAKAŞ
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Hamza KÜÇÜK Fatih KARAKAŞ
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Hamza KÜÇÜK Fatih KARAKAŞ

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Etik Kurul Beyanı/ *Statement of Ethics Committee*

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