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Comparison of Lower Extremity Bilateral and Ipsilateral Strength Asymmetry in Male and Female Soccer Players

Erkek ve Kadın Futbolcularda Alt Ekstremite Bilateral ve İpsilateral Kuvvet Asimetrisinin Karşılaştırılması

Gizem AKARSU TAŞMAN[1]
[1]Mersin University, Faculty of Sports Sciences, Physical Education and Sports Teaching, Mersin, Türkiye

Erkan GÜVEN[2]
[2]Mersin University, Faculty of Sports Sciences, Coaching Education, Mersin, Türkiye

Nasuh Evrim ACAR[3]
[3]Mersin University, Faculty of Sports Sciences, Department of Sports Management, Mersin, Türkiye

ABSTRACT

The aim of this study was to compare bilateral and ipsilateral lower extremity strength asymmetry in male and female soccer players. This study was conducted with cross-sectional research model. In the study, 74 soccer players (36 women and 38 men) who play soccer in Mersin province participated voluntarily. The body composition of the participants was measured by bioelectrical impedance analysis and isokinetic strength was measured by Cybex II Norm isokinetic dynamometer. Isokinetic strength test was performed for both knees at 60 °/s for 3 sets 5 repetitions. Bilateral and ipsilateral force asymmetry were calculated with formulas based on peak torque force. Since bilateral force asymmetry values were not normally distributed, Mann Whitney U test was performed, and since ipsilateral force asymmetry values were normally distributed, independent sample t test was performed. When the bilateral strength asymmetry of male and female soccer players were compared, it was observed that there was a significant difference in both quadriceps (p <.02) and hamstring muscle groups strength asymmetry (p <.01). In the ipsilateral force asymmetry values, it was observed that there was no significant difference between genders (p >.05). When the ipsilateral force asymmetry values were examined, it was observed that male soccer players (56.04%-55.21%) had more ideal values than females (54.49%-53.88%). As a result, in our study findings, it was observed that the strength asymmetry values of the athletes were at an ideal level and there was a difference between the genders in bilateral asymmetry, but there was no difference in ipsilateral asymmetry.

Keywords: Football,Isokinetic Strength, Bilateral, Ipsilateral, Strength Asymmetry

ÖZ

Bu araştırmada, kadın ve erkek futbolcuların alt ekstremite bilateral ve ipsilateral kuvvet asimetrisinin karşılaştırılması amaçlanmıştır. Bu çalışma, kesitsel araştırma modeli ile gerçekleştirilmiştir. Araştırmaya Mersin ilinde futbol oynayan 74 futbolcu (36 kadın 38 erkek) gönüllü olarak katılmıştır. Katılımcıların vücut kompozisyonu ölçümleri bioelektrik impedans analizi ile izokinetik kuvvet ölçümleri ise Cybex II Norm izokinetik dinamometre ile ölçülmüştür. İzokinetik kuvvet testi 60 °/s'de 3 set 5 tekrar olmak üzere her iki diz için de uygulanmıştır. Bilateral ve ipsilateral kuvvet asimetrisi zirve tork kuvveti üzerinden formüller ile hesaplanmıştır. Bilateral kuvvet asimetrisi değerleri normal dağılım göstermediği için Mann-Whitney U testi, ipsilateral kuvvet asimetrisi değerleri normal dağılım gösterdiği için bağımsız örneklem t testi yapılmıştır. Kadın ve erkek futbolcuların bilateral kuvvet asimetrisi karşılaştırıldığında hem quadriceps (p <,02) hem de hamstring kas grupları kuvvet asimetrelerinde (p <,01) anlamlı farklılık olduğu görülmüştür. İpsilateral kuvvet asimetrisi değerlerinde ise cinsiyetler arasında anlamlı farklılık olmadığı (p >,05) gözlemlenmiştir. İpsilateral kuvvet asimetri değerlerine bakıldığında erkek futbolcuların (%56,04 - %55,21) kadınlara oranla (%54,49 - %53,88) daha ideal değerlere sahip olduğu gözlenmiştir. Sonuç olarak, çalışma bulgularımızda, sporcuların kuvvet asimetrisi değerlerinin ideal düzeyde olduğu ve cinsiyetler arasında bilateral asimetride fark olduğu, ipsilateral asimetride ise farklılık olmadığı görülmüştür.

Anahtar Kelimeler: Futbol, İzokinetik Kuvvet, Bilateral, İpsilateral, Kuvvet Asimetrisi

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Sorumlu Yazar/Corresponding author:
Gizem AKARSU TAŞMAN
E-mail: gizemakarsu88@gmail.com
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Introduction

Soccer is a team sport with dynamic and high physical demands, where endurance, strength, explosive power, and repeated sprinting abilities have been shown to be important factors in determining success (Bangsbo et al., 2006; Hoff & Helgerud, 2004). During soccer training and competitions, lower limb strength is crucial to perform different specific actions such as acceleration, deceleration, changing direction or sprinting (Ruscello et al., 2018). Especially during competition, athletes frequently use unilateral movements such as passes, runs, and shots to change the running direction (Pinniger et al., 2000). Studies have shown that there may be asymmetries in the force generating capacity and biomechanical structures of athletes during these movements, and the resulting force asymmetry may negatively affect performance and cause injuries (Lehance et al., 2009; Masuda et al., 2005).

The majority of injuries that occur in a professional soccer team during the season occur in the lower extremities. Considering the time to return to play, hamstring injuries and anterior cruciate ligament ruptures are the most serious injuries (Walden et al., 2016). The knee joint is one of the most commonly injured joints in soccer players and is under great load during movements such as changing direction (Boden et al., 2000). The presence of strength asymmetries in the lower extremities in soccer players is critical for their physical health and injury management (Lehance et al., 2009). Studies indicate that female athletes in team sports are more prone to lower extremity injuries, especially anterior cruciate ligament injuries are more common in women and the reason for this may be anatomical and hormonal differences (Deda & Kalaja, 2015).

Soccer is a complex sport that requires the repetition of many different movements and consists of many different technical elements. Some technical elements are performed with the ball, others without; many are performed with the player's feet, others with other parts of the body. Many of these are unilateral, such as goal kicks, passes, dribbling, leaps, changes of direction and tackles. It has been noted that performing repetitive and prolonged non-repetitive movements with a unilateral movement pattern can cause differences between two body parts or between agonists and antagonists of the same body part. More frequent use of the dominant leg often leads to the development of musculoskeletal imbalances and increased unilateralism. Muscular imbalance may be related to the player's age, years of training and playing position (Zeleznik et al., 2025).

Strength differences between agonist and antagonist muscles of athletes are one of the best test parameters to determine injury tendency (Maly et al., 2017). Measurements with isokinetic dynamometers under laboratory conditions are one of the most valid and reliable markers that objectively demonstrate knee joint extensor and flexor muscle strength with both eccentric and concentric contractions (Brown, 2000). Force asymmetry refers to bilateral or ipsilateral ratios of maximal force values of both legs relative to a reference point (Bishop et al., 2017; Impellizzeri et al., 2007). It has been reported that a bilateral muscle strength asymmetry of more than 10-15% increases the risk of injury, while a hamstring/quadriceps (H/Q) strength ratio of less than 60% is associated with lower extremity injuries (Kim & Hong, 2011).

Strength asymmetries in the lower extremities can directly affect sportive performance and are of great importance in terms of measures to be taken to prevent injuries in the long term. Strength asymmetry can be affected by the laxity of the ligaments in the knee joint, anatomical structure, and gender-related factors such as hormonal status and menstrual cycle (Daneshjoo et al., 2013). Physiological differences between male and female athletes, such as body mass, muscle mass and fat percentage, can affect both quadriceps and hamstring peak torque force and force asymmetry. Although it has been reported that female athletes have lower force generating capacity than male athletes, more studies are needed to determine whether lower extremity force asymmetry is affected by gender (Daneshjoo et al., 2013; Lephart et al., 2002). When the literature is examined, there are inconsistencies in the results of the studies (Holm & Vollestad, 2007; Maly et al., 2015) as well as studies reporting that force asymmetry differs according to gender (Hewett et al., 2008; Kaçoğlu, 2019). It is seen that there are inconsistent results in the studies and more research is needed. In this context, comparing strength asymmetries between both male and female soccer players will allow for a better understanding of the biomechanical profiles of soccer players and the development of more effective rehabilitation strategies for athletes. Accordingly, the aim of this study was to compare bilateral and ipsilateral strength asymmetries in the lower extremities of male and female soccer players. In line with this study, determining the biomechanical differences between male and female soccer players may help to design special training programs for athletes. In addition, determination of strength asymmetry profiles will provide an important

source of information for the prevention and treatment of potential injuries in the lower extremities of soccer players.

Methods

Research Model

This study was conducted with a cross-sectional research model. Cross-sectional studies aim to reveal the differences between groups by evaluating the characteristics of a group of participants at a given moment (Cohen, 2018). Participants were included in the study using purposive sampling method. The athletes were informed about the purpose and process of the study according to the Declaration of Helsinki. Written informed consent was obtained from the participants on a voluntary basis. Before starting the study, approval was obtained from Mersin University Sports Sciences Ethics Committee (Date: November 8, 2024, Number: 069).

Participants

In order to determine the sample size, G*Power analysis was performed with reference to the study conducted by Harbili et al. (2022) (5% margin of error, 95% power) and the sample size was determined as at least 16 people for each group and 32 people for 2 groups. While the population of this study consisted of male and female amateur soccer players in Mersin province, the sample group consisted of a total of 74 soccer athletes, 36 female and 38 male, who played active soccer in Mersin province and participated in the study voluntarily. Athletes who were between the ages of 18-27, had at least 5 years of sports history, had not suffered any injury in the last 6 months and were actively playing soccer were included in this study.

Applied Tests

The body composition and isokinetic strength tests of the participants were performed by the researchers at Mersin University, Faculty of Sport Sciences, Physical Profile, Performance and Biomechanics Laboratory. In order not to affect the results of the study, the temperature was kept between 21-22°C and humidity between 45-55% and the tests were performed under controlled conditions.

Body Composition Measurements

Body composition characteristics of the athletes participating in the study were measured by Bioelectrical Impedance Analysis (Tanita BC418 Japan). Participants were informed about the procedure before the measurement. The measurements were made with sportswear (shorts, tank top), without shoes, weight measurements on a scale with an error of ± 0.1; height measurements were made with a stadiometer (Holtain Ltd. U.K.) with an error of ± 1 mm, the distance between the vertex of the head and the foot following a deep inspiration with the head in the frankfort plane.

Isokinetic Strength Measurements

Knee joint extensor and flexor isokinetic strength measurements of the participants were performed with Cybex II Norm isokinetic dynamometer. Before the test, the participants were warmed up on the treadmill for 10 minutes, including 5 minutes of running and 5 minutes of dynamic movements. After 10 repetitions at 180 °/s angular velocity using Humac Norm CSMI Cybex isokinetic dynamometer, the same test was performed for both knees for 3 sets x 5 repetitions at 60 °/s. A 30-second rest interval was given to rest between sets. During the test, the torso and thighs of the participants were fixed to the seat with adhesive tapes and the ankle joint was fixed to the dynamometer arm with a padded pad. The range of motion was set to 90° for all participants and kept constant. Calibration and gravity correction were adjusted in accordance with the values given by the isokinetic dynamometer. The participants were informed before the tests and given detailed information about the test. Verbal motivation was also provided during the test. Bilateral and ipsilateral strength asymmetries of the athletes were calculated with the following formulas.

Bilateral (contralateral) force asymmetry refers to the force comparison between two limbs. In this study, quadriceps and hamstring isokinetic peak torque data were obtained by flexion and extension of the knee joint at 60 °/s. The force asymmetry between the two limbs for both quadriceps and hamstring muscles (Q/Q and H/H) ;

(High Peak Torque-Low Peak Torque) / High Peak Torque x 100.

Ipsilateral force asymmetry is the imbalance of agonist and antagonist muscle force in the same limb. In this study, quadriceps and hamstring isokinetic peak torque data were taken and right leg and left leg ipsilateral force difference (H/Q) was calculated as a percentage with the following formula.

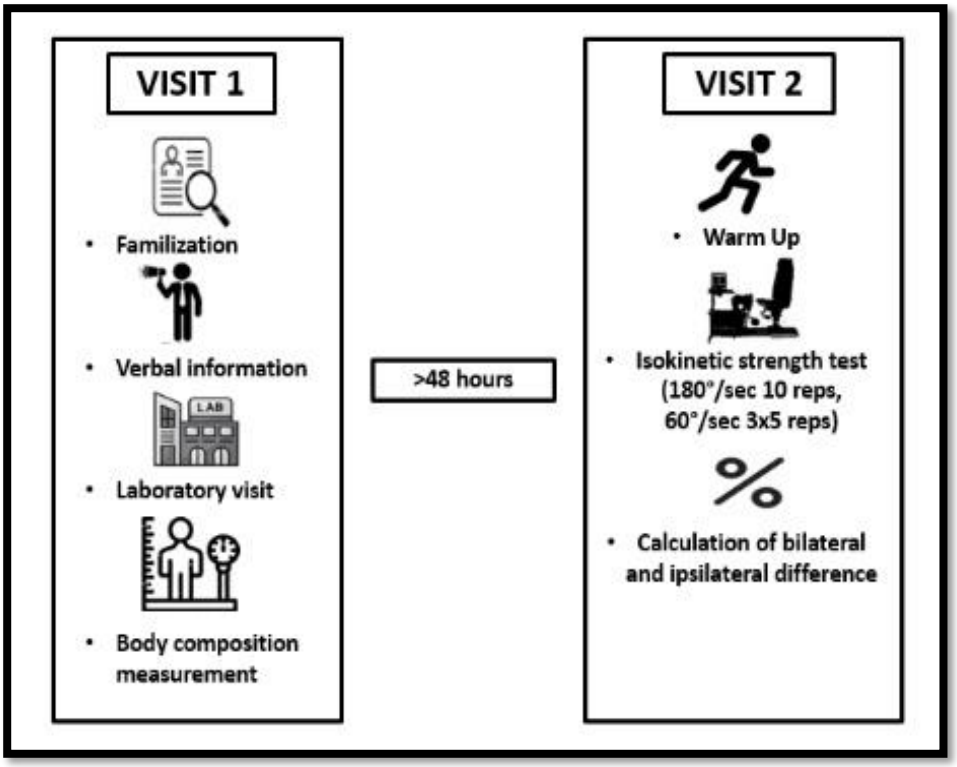
(Hamstring Peak Torque/Quadriceps Peak Torque) X 100 (Gleim et al., 1978).

Research Design

Participants had two laboratory visits. In the first laboratory visit, exercise trainings and body composition measurements were made to introduce the test equipment. In the second visit, isokinetic strength test was performed after warming up. Participants were warned not to engage in strenuous physical activity or drink alcohol or caffeine in the last 24 hours before the tests.

Figure 1.

Study Design



Statistical Analysis

SPSS (version 22) program was used for data analysis. Arithmetic mean, standard deviation, minimum and maximum values were calculated for the demographic information of the participants. The conformity of the data to normal distribution was checked by Shapiro-Wilk test. Since bilateral strength asymmetry values of male and female soccer players did not show normal distribution, Mann Whitney U test was performed. Since ipsilateral strength asymmetry values showed normal distribution, independent sample t test was performed. The significance level was accepted as p <.05.

Results

Table 1.
Demographic variables of the participants

Variable	Gender	min	max	(X̄)	SD
Age (years)	Female (n:36)	19.00	27.00	21.86	1.53
	Male (n:38)	18.00	25.00	21.42	1.78
Height (cm)	Female (n:36)	152.00	172.00	161.80	5.05
	Male (n:38)	163.00	191.00	175.15	5.73
Weight (kg)	Female (n:36)	43.90	71.10	54.71	7.16
	Male (n:38)	58.70	92.50	70.61	8.41
Body Mass Index (kg/m²)	Female (n:36)	17.15	26.44	20.88	2.42
	Male (n:38)	17.86	29.32	23.02	2.57
Right Extension Peak Torque (Nm)	Female (n:36)	107.00	184.00	137.11	20.92
	Male (n:38)	148.00	282.00	222.50	29.41
Right Flexion Peak Torque (Nm)	Female (n:36)	56.00	104.00	74.25	12.67
	Male (n:38)	81.00	164.00	124.63	19.50
Left Extension Peak Torque (Nm)	Female (n:36)	100.00	175.00	133.66	19.77
	Male (n:38)	156.00	259.00	212.94	26.98
Left Flexion Peak Torque (Nm)	Female (n:36)	56.00	100.00	72.52	11.62
	Male (n:38)	87.00	154.00	118.10	15.78
Bilateral Difference (%) (Q/Q)	Female (n:36)	0.00	11.57	5.66	3.67
	Male (n:38)	0.78	22.01	8.23	4.84
Bilateral Difference (%) (H/H)	Female (n:36)	0.00	18.31	5.59	4.41
	Male (n:38)	0.00	21.24	9.48	5.21
Ipsilateral Difference (%) (H/Q Right)	Female (n:36)	35.09	71.23	54.49	7.92
	Male (n:38)	34.91	71.50	56.04	7.35
Ipsilateral Difference (%) (H/Q Left)	Female (n:36)	41.54	67.46	53.88	6.69
	Male (n:38)	42.20	70.29	55.21	6.45

Nm: Newton meter; Q/Q: Quadriceps/Quadriceps; H/H: Hamstring/Hamstring; H/Q: Hamstrings/Quadriceps

Table 2.
Difference analysis of bilateral strength asymmetry in male and female soccer players

Variable	Gender	n	X̄	SD	Z	*p*
Bilateral Difference (%) (Q/Q)	Female (n:36)	36	5.66	3.67	-2.287	**.02***
	Male (n:38)	38	8.23	4.84		
Bilateral Difference (%) (H/H)	Female (n:36)	36	5.59	4.41	-3.267	**.01***
	Male (n:38)	38	9.48	5.21		

p <.05*, Q/Q: Quadriceps/Quadriceps; H/H: Hamstring/Hamstring

When the bilateral strength asymmetry of male and female soccer players were compared, it was observed that there was a significant difference between both quadriceps (*p* <.02) and hamstring muscle groups (*p* <.01) (Table 2). In both muscle groups, male soccer players had higher asymmetry than female soccer players.

Table 3.
Difference analysis of ipsilateral force asymmetry in male and female soccer players

Variable	Gender	n	X̄	SS	t	*p*
Ipsilateral Difference (%) (H/Q Right)	Female(n:36)	36	54.49	7.92	-0.870	.89
	Male (n:38)	38	56.04	7.35		
Ipsilateral Difference (%) (H/Q Left)	Female(n:36)	36	53.88	6,69	-0.871	.68
	Male (n:38)	38	55.21	6.45		

H/Q: Hamstrings/Quadriceps

In table 3, it was observed that the participants had similar ipsilateral force asymmetry and there was no significant difference. When H/Q force asymmetry values were analyzed, it was observed that male soccer players had more ideal values than females.

Discussion

This study, which investigates the bilateral and ipsilateral strength asymmetries of female and male football players, reveals two significant findings. The first is that the bilateral difference, defined as the strength disparity between the two limbs, is significant, and female players are closer to ideal values. The second finding is that there is no gender difference in ipsilateral strength asymmetry, and male athletes are closer to the ideal values.

The study found that female athletes exhibited a bilateral strength asymmetry of Q:Q = 5.66%, H:H = 5.59%, while male athletes had a bilateral strength asymmetry of Q:Q = 8.23%, H:H = 9.48%. Ipsilateral strength asymmetry was found to be 54.49% and 53.88% in females, and 56.04% and 55.21% in males. These findings suggest that the strength asymmetry values of the athletes participating in the study are close to the ideal values indicated in the literature. In line with our study, Aginsky et al. (2014) conducted a study on elite football players and reported that the players' bilateral (<10%) and ipsilateral strength asymmetries (64.7% and 60.9%) were at ideal levels. In another study, Maly et al. (2021) investigated the bilateral strength asymmetry in football players and found the Q:Q ratio to be 8.49% and the H:H ratio to be 10.00%. Ipsilateral strength asymmetry was reported as 60.50% and 58.40%. Similarly, Maly et al. (2016) conducted isokinetic strength tests at different angular velocities to examine strength asymmetries in elite footballers. They discovered that the bilateral asymmetry in knee flexors (H:H = 9.02%-12.61%) was higher than in knee extensors (Q:Q = 6.32%-7.15%). This finding aligns with our study results, where both male and female footballers exhibited higher hamstring muscle asymmetry compared to quadriceps asymmetry. In a similar study, Menzel et al. (2013) reported that lower extremity asymmetries measured through isokinetic strength tests in professional football athletes ranged between 10%-15%. They also noted that asymmetries in isokinetic strength were associated with decreased performance in explosive activities such as jumping and sprinting, and with lower extremity injuries.

Research has highlighted the negative impact of strength asymmetry in the lower extremity on injury risk. Strength differences between limbs have been shown to predispose athletes to non-contact injuries, such as anterior cruciate ligament (ACL) tears, hamstring injuries, and ankle sprains. Exell et al. (2017) stated that footballers with lower extremity asymmetry were more prone to muscle injuries over the course of a season. Likewise, Hart et al. (2014) demonstrated that hamstring strength asymmetry was associated with an increased risk of hamstring injuries. These studies suggest that asymmetry disrupts neuromuscular coordination and joint stability, leading to movement patterns that increase injury susceptibility. Croisier et al. (2008) found that training interventions aimed at correcting strength asymmetries in professional football players significantly reduced hamstring injury rates. This finding underscores the importance of identifying and addressing asymmetries through personalized training programs to enhance performance and minimize injury risks.

Research on strength asymmetry has generally focused on male football players. Costa Silva et al. (2015) reported no significant differences in bilateral and ipsilateral strength asymmetries in U20 male footballers. However, they noted significant differences based on players' positions (defenders, midfielders, and forwards).

A review of the literature reveals a lack of research on female football players, who, due to physiological and biomechanical differences, may experience varying injury risks and performance effects. Addressing this gap is important for developing training interventions that could reduce injury risks and optimize performance. The findings of previous studies show both parallel and contradictory results compared to ours. Kaçoğlu (2019), investigated gender differences in lower extremity strength asymmetry and found that strength asymmetry did not vary by gender. Harbili et al. (2022) compared strength asymmetries in female and male taekwondo athletes using isokinetic and isometric tests (60°/s), and found no differences in bilateral strength asymmetry between female (11%) and male (15%) athletes. In terms of H/Q asymmetry, no gender or limb differences were observed, similar to our study results. Parpa and Michaelides (2022), compared strength asymmetries using isokinetic strength tests across different sports. They found no significant differences in bilateral strength asymmetry between male (Q/Q: 8.37%, H/H: 9.33%) and female (Q/Q: 12.80%, H/H: 8.65%) football players. However, in this study, which included volleyball, football, and basketball comparisons, female football players were reported to have the highest strength

asymmetry. In contrast, our findings suggest that female football players' bilateral strength asymmetry levels are closer to ideal values compared to male players (Table 2). Bailey et al. (2015) in their study investigating the gender difference in isometric strength and CMJ tests, reported that females had higher asymmetry compared to males. Similarly, Bell et al., (2014) stated that female athletes exhibited higher strength asymmetry compared to their male counterparts. The strength asymmetry in female athletes should not be overlooked, as certain injuries, such as ACL tears, occur at higher rates in women than in men. In this study, male athletes were found to have higher strength asymmetry. These differences are thought to stem from variations in sports experience, sport-specific repetitive asymmetric movements, or inadequate rehabilitation following previous injuries. Research on strength asymmetry in female football players is limited, with most studies focusing on elite male players. However, the physiological and biomechanical differences between genders suggest that strength asymmetry may affect female athletes in distinct ways (Delang et al., 2021). Female athletes tend to exhibit greater strength asymmetry and are more susceptible to specific injuries, such as ACL tears (Hewett et al., 2006). Further research is needed to determine whether reducing strength asymmetry can help reduce injury risks in female football players (Loturco et al., 2019).

Conclusion and Recommendation

In conclusion, our study findings show that the strength asymmetry values of the athletes were at ideal levels and there was a significant difference between the genders in bilateral asymmetry in favor of women, while there was no difference in ipsilateral asymmetry. It was found that female football players had more ideal bilateral strength asymmetry than male football players. However, there are also studies in the literature reporting that female football players have more strength asymmetry. It was also seen that the studies conducted on female football players were limited. In this direction, conducting research on female football players in larger populations may help to determine biomechanical differences and design specific training programs. Future research should focus on expanding our knowledge of strength asymmetry, especially in female football players, and evaluating the effectiveness of specific training and rehabilitation programs designed to reduce the risks associated with asymmetry.

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Yazar Katkıları: Fikir-G.A.T.; EG; Tasarım-G.A.T.;,E.G.; Denetleme-N.E.A.; Kaynaklar-G.A.T., E.G., N.E.A.; Veri Toplanması ve/veya İşlemesi G.A.T., E.G., N.E.A.; Analiz ve/ veya Yorum-E.G.; Literatür Taraması-G.A.T.; Yazıyı Yazan-G.A.; Eleştirel İnceleme-N.E.A.
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