ORİJİNAL MAKALE / ORIGINAL ARTICLE
Balıkesir Sağlık Bilimleri Dergisi/ BAUN Sağ Bil Derg
Balıkesir Health Sciences Journal / BAUN Health Sci J
ISSN: 2146-9601-e ISSN: 2147-2238
Doi: https://doi.org/10.53424/balikesirsbd.1618091

Static and Dynamic Core Stability's Relationship with Agility and Speed in Female Basketballers

Esra KESKİN[1], Burçin AKÇAY[1], Ozan Bahadır TÜRKMEN[1], Şule KEÇELİOĞLU[1]

[1]Bandırma Onyedi Eylül University, Faculty of Health Sciences, Department of Physical Therapy and Rehabilitation

GelişTarihi / Received:*12.01.2025,* ***Kabul Tarihi / Accepted:*** *19.03.2025*

ABSTRACT

Objective: This study aims to investigate the relationship between static and dynamic core stabilization with agility and speed among female basketball players. Core stability, encompassing static and dynamic components, is fundamental for maintaining balance and enhancing athletic performance. **Materials and Methods:** Fifteen female athletes from the Bandırma Basketball Team participated, undergoing a series of core stability, agility, and speed assessments. These included the plank and double leg lowering test for static core stability, back extensions for dynamic core stability, the Hexagonal Obstacle Test (HOT) for agility, and a 20-meter sprint test for speed. **Results:** The results revealed a significant positive correlation between static core stability (plank test) and speed performance (r=0.576, p=0.025), suggesting that greater static core stability enhances sprinting capability. However, no significant correlations were observed between dynamic core stability (back extensions) and either agility or speed. Additionally, agility and speed showed a moderate correlation (r=0.569, p=0.027), indicating a mutual influence. **Conclusion:** These findings highlight the importance of static core stability for speed performance and suggest that training programs for basketball athletes could benefit from emphasizing static core exercises to enhance sprinting ability.

Keywords: Athletic Performance, Basketball, Core Stability.

Bayan Basketbolcularda Statik ve Dinamik Kor Stabilizasyonun Çeviklik ve Hız ile İlişkisi

ÖZ

Amaç: Bu çalışma, kadın basketbolcularda statik ve dinamik kor stabilizasyonunun çeviklik ve hız ile ilişkisini araştırmayı amaçlamaktadır. Statik ve dinamik bileşenleri içeren kor stabilitesi, dengeyi korumak ve atletik performansı artırmak için temel bir unsurdur. **Gereç ve Yöntemler:** Bandırma Basketbol Takımı'ndan 15 kadın sporcu çalışmaya katılmıştır. Katılımcılar, kor stabilitesi, çeviklik ve hız değerlendirmelerini içeren bir dizi teste tabi tutulmuştur. Bu testler arasında statik kor stabilitesi için plank ve çift bacak indirme testi, dinamik kor stabilitesi için sırt ekstansiyonları, çeviklik için Altıgen Engel Testi (HOT) ve hız için 20 metre sprint testi yer almıştır. **Bulgular:** Sonuçlar, statik kor stabilitesi (plank testi) ile hız performansı (r=0.576, p=0.025) arasında anlamlı bir pozitif korelasyon olduğunu ortaya koymuştur; bu da daha iyi bir statik kor stabilitesinin sprint yeteneğini artırdığını göstermektedir. Bununla birlikte, dinamik kor stabilitesi (sırt ekstansiyonları) ile çeviklik veya hız arasında anlamlı bir ilişki bulunmamıştır. Ayrıca, çeviklik ve hız arasında orta düzeyde bir korelasyon (r=0.569, p=0.027) saptanmış olup, bu iki parametrenin karşılıklı bir etkiye sahip olduğunu göstermektedir. **Sonuç:** Bu bulgular, hız performansı için statik kor stabilitesinin önemini vurgulamakta ve basketbol sporcuları için hazırlanacak antrenman programlarında sprint yeteneğini geliştirmek amacıyla statik kor egzersizlerine ağırlık verilmesi gerektiğini önermektedir.

AnahtarKelimeler: Atletik Performans, Basketbol, Kor Stabilite.

SorumluYazar / Corresponding Author: Esra KESKİN, Bandırma Onyedi Eylül University, Faculty of Health Sciences, Department of Physical Therapy and Rehabilitation, Balikesir, Türkiye.
E-mail:ekeskin@bandirma.edu.tr

Bu makaleyeatıfyapmakiçin / Cite this article: Keskin, E., Akçay, A., Türkmen, O., & Keçelioğlu, Ş. (2025). Static and dynamic core stability's relationship with agility and speed in female basketballers. *BAUN Health Sci J, 14*(1), 204-209. https://doi.org/10.53424/balikesirsbd.1618091

BAUN Health Sci J, OPEN ACCESS https://dergipark.org.tr/tr/pub/balikesirsbd
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INTRODUCTION

Basketball is a sport that encompasses various activities, including running and jumping. While both aerobic and anaerobic performance are crucial for basketball, it also demands muscle strength, endurance, flexibility, speed, agility, and basketball-specific skills (Pojskić et al., 2015). Enhancing these skills is known to contribute to overall athlete performance (Abdelkrim et al., 2007). In addition to basketball-specific skills, research suggests that postural stability plays a role in improving basketball performance (Hammami et al., 2014). Postural stability is defined as the ability to maintain the center of gravity within the support surface with minimal postural sway (Barati et al., 2013). The somatosensory system, visual system, and vestibular system collaborate to ensure postural stability (Gribble & Hertel, 2003).

Alongside postural stability, optimal core stability is vital for athletic performances involving body oscillation (Gribble & Hertel, 2003). The core, considered the center of the functional kinetic chain, provides proximal stability necessary for the distal mobility of extremities (Clark et al., 2018). Core strength is a prerequisite for various sports, including football, athletics, basketball, as well as daily activities like walking, standing upright, and climbing stairs (Ozmen, 2016; Räisänen et al., 2018) The core facilitates bidirectional force transmission between the lower and upper appendicular pathways while ensuring stability in the lumbosacral area (Akuthota et al., 2008; Huxel Bliven & Anderson, 2013). The core region is classified into two groups: local and global (Akuthota et al., 2008). The local group comprises small muscles responsible for deep stabilization between vertebrae, whereas the global group consists of large, superficial muscles transferring force between the rib cage and pelvis, playing a role in creating movement (Akuthota et al., 2008). Strengthening the core, the center of most kinetic chains, enhances balance, movement control, and extremity function, making movements more powerful and efficient (McCurdy et al., 2005). Core stabilization can be achieved through two basic types of training: static and dynamic. Static training involves engaging joints and muscles either by exerting force against an immovable object (maximal effort) or by holding a static position (submaximal effort) while resisting applied resistance (Huxel Bliven & Anderson, 2013). Dynamic training involves the repeated or continuous use of muscle force, concentrically or eccentrically, associating it with stabilization (Kulas et al., 2006). Core stabilization is evaluated using tests categorized as static and dynamic core stabilization (Parkhouse & Ball, 2011).

Agility, defined as the ability to change direction without losing speed, postural control, and core stability, is closely related to these components (Turner et al., 2011). Rapidly changing the direction and speed of the body's center of gravity is a fundamental locomotor ability in many sports. Muscles outside the core region have demonstrated that dynamic exercises are more effective for improving performance in dynamic tasks, whereas static exercises are better suited for enhancing static task performance. Isometric force duration has been reported to poorly correlate with dynamic performance (Haff et al., 2005). Studies in the literature indicate the positive effects of core training on agility and balance (Saeterbakken et al., 2011). Some sports disciplines also highlight the relationship between stability (Imai &Kaneoka, 2016); however, there is limited research focusing specifically on basketball players (Cengizhan et al., 2019). Similarly, studies examining the relationship between speed a critical factor in athletic performance and stabilization have reported varying results. While some studies suggest that stabilization training enhances speed in athletes (Luo et al., 2022), others report no significant effect (Werasirirat et al., 2022). Furthermore, to the best of our knowledge, no research in the literature has investigated the relationship between performance parameters such as agility and speed and both static and dynamic core stability. Therefore, this study aims to investigate the relationship between static and dynamic core stabilization with agility, and speed in basketball players.

MATERIAL AND METHODS

The study was conducted with the members of the Bandırma Basketball Team in the practice laboratories of the Bandırma Onyedi Eylül University Physiotherapy and Rehabilitation Department. The study was carried out during the period between May and June 2023. The sample size for the research was initially calculated as 15 using the G*power application ($\alpha = 0.05$, with a confidence interval of 0.90). Female basketball players under the age of 18 were included in the study, while individuals with a history of previous orthopedic injury or surgery, neurological, neuromuscular, or musculoskeletal deficits, as well as those with vestibular and systemic diseases, were excluded from the study.

This study was designed and conducted in compliance with the principles outlined in the 1975 Declaration of Helsinki (revised in 2013). Participants, who were informed about the study's scope, were required to sign the Informed Consent Form.

Data collection

Demographic Information Form: It is a form that inquires the personal details such as participant's no, age (years), heigh (cm), body weight (kg), body mass index (kg/m2) dominant extremity, health status, previous injuries, operations and existing diseases.

Static core stabilization tests

Plank: Plank is a test used to assess static core stabilization (Parkhouse & Ball, 2011). The use of the

plank test to assess global muscular endurance in athletes has demonstrated validity and reliability, with an ICC (Intraclass Correlation Coefficients) value= 0.99 (95% CI: 0.98-0.99) (Tong et al., 2014). The test is performed by recording the time that the participant, who is positioned flat on the forearms and feet in the prone position, can maintain this position.
Double Leg Lowering: The double leg lowering maneuver is a commonly used test especially to assess the strength of the abdominal muscles. Studies have indicated that this test is also a suitable tool for evaluating stabilization, with a high reliability of r=0.932 (Ladeira et al., 2005). During the test, participants lying on their backs are instructed to keep their legs 5 cm above the ground with knees straight, and the duration they can maintain this position is recorded in seconds (Parkhouse & Ball, 2011).

Dynamic core stabilization test

Back Extensions: This test is employed to assess the dynamic strength of the trunk extensor muscles (Moreland et al., 1997). In a study, the reliability of the test was reported to be high, with an intraclass correlation coefficient (ICC) of 0.98 and a standard error of measurement (SEM) of 1.0 repetitions (Lanning et al., 2006). The test involves recording the number of repetitions of trunk extensions performed in the prone position over a 2-minute duration as a score (Parkhouse & Ball, 2011).

Agility assessment

Hexagonal Obstacle Test (HOT): This test is utilized to evaluate agility, particularly in athletes. Participants position their feet facing forward in the center of a hexagon with each side measuring 66 cm and corners forming angles of 120 degrees on the ground. The test involves jumping clockwise from side to side, returning to the center, and completing the hexagon in this manner. The time taken to complete three rounds is recorded (Cengizhan et al., 2019).

Speed assessment

20 m Sprint (Speed) Test: This test comes in various variations and can be conducted at different distances, such as 5 meters, 10 meters, and 20 meters. The 20-meter sprint test, commonly encountered in the literature, is utilized for assessing speed. A timer is used to record and score the participant's time to complete the 20-meter course (Parkhouse & Ball, 2011).
Participants were provided with 2-minute rest intervals between tests. A single assessment session was conducted, and the evaluations lasted approximately 20 to 25 minutes.

Statistical analyses

IBM SPSS Statistics 23 (Statistical Package for Social Sciences) was used for statistical analyses. Descriptive statistics for demographic data and test results were provided. In descriptive statistics, numerical variables with Mean±Standard Deviation (SD) values, and categorical variables with frequency (n) and percentage (%) values were given. Shapiro-Wilk, and Skewness-Kurtosis values were used for normality analysis. Correlation data between static and dynamic core tests, agility and speed were analyzed using Pearson Correlation Analysis, as the data were normally distributed.

Ethical considerations

This descriptive study received approval from the Bandırma Onyedi Eylül University Faculty of Health Sciences Non-Invasive Clinical Research Ethics Committee (Date: 30.10.2020; Approval no: 2020-41).

RESULTS

The study involved a sample of 15 female basketball players with a mean age of 16.73±2.46 years. The participants had a mean weight of 60.86±7.71 kg, height of 174.06±7.89 cm, and a body mass index (BMI) of 20.06±2 kg/m². All participants were right-hand dominant, with no left-handed players in the study (Table 1).

Table 1. Demographic characteristics of participations (n=15).

Female Basketball Players (n=15)	X±SD
Age (year)	16.73±2.46
Weight (kg)	60.86±7.71
Height (cm)	174.06±7.89
BMI (kg/m²)	20.06±2.00
Dominant extremity (%)	
Right	15 (%100)
Left	0

Core Stability and agility correlation

Pearson correlation analysis revealed key relationships between static and dynamic core stability tests, agility (HOT), and speed tests. The plank test, used to assess static core stability, showed a significant positive correlation with the speed test (r=0.576, p=0.025), indicating that greater static core stability is associated with faster sprint performance. However, no significant correlation was observed between the plank test and the agility test (HOT) (r=0.436, p=0.104) (Table 2).

The double leg lowering test, used to assess abdominal muscle strength and core stabilization, did not show a significant correlation with either the agility test (r=0.172, p=0.39) or the speed test (r=-0.365, p=0.180) (Table 2).

For the back extensions test, which measures dynamic core strength, no significant correlation was found with agility (r=0.095, p=0.737) or speed (r=0.019, p=0.946).

Agility and speed correlation

A significant positive correlation was observed between the agility test (HOT) and the speed test (r=0.569, p=0.027), indicating that better agility is associated with faster sprinting ability among the basketball players (Table 2).

Summary of key findings

The results suggest that static core stability, as measured by the plank test, plays a crucial role in sprint performance. However, dynamic core stability, as measured by the back extensions test, does not appear to significantly influence agility or speed. Agility and speed are strongly correlated, suggesting that improvements in one may contribute to enhancements in the other.

These findings highlight the importance of static core stability in speed performance and suggest a potential focus for training programs aimed at improving basketball performance.

Table 2. Correlations of static and dynamic core stabilization tests with agility and speed(n:15).

		Plunk	Double Leg Lowering	Back Extensions	HOT	Speed Test
Plunk	**r**	1	0.196	-0.30	0.436	0.576
	p		0.485	0.915	0.104	0.025
Double Leg Lowering	**r**	0.196	1	-0.212	0.172	-0.365
	p	0.485		0.447	0.39	0.180
Back Extensions	**r**	-0.30	-0.212	1	0.095	0.019
	p	0.915	0.447		0.737	0.946
HOT	**r**	0.436	0.172	0.095	1	0.569
	p	0.104	0.39	0.737		0.027
Speed Test	**r**	0.576	-0.365	0.019	0.569	1
	p	0.025	0.180	0.946	0.027	

DISCUSSION

The current study aimed to investigate the relationship between static and dynamic core stabilization with agility and, speed in female basketball players. The findings indicate that static core stability, as assessed through the plank test, is significantly correlated with sprint performance, while dynamic core stability, as measured by back extensions, does not show a significant correlation with either agility or speed.

These results align with previous research suggesting that core stability is fundamental for athletic performance, particularly in sports requiring rapid changes in direction and speed (Gribble &Hertel, 2003). The significant correlation found between the plank test and the 20 m sprint test highlights the importance of static core strength in enhancing sprinting abilities. This is consistent with findings by Abdelkrim et al., who noted that muscle strength and endurance contribute to overall athletic performance (Abdelkrim et al., 2007). The ability to maintain core stability allows athletes to effectively transmit force through the kinetic chain, facilitating improved speed during dynamic movements (Akuthota et al., 2008). Although some studies in the literature suggest that core stabilization strengthening training does not affect speed in athletes (Werasirirat et al., 2022), more recent and comprehensive publications highlight the potential of core stabilization training programs to enhance speed (Luo et al., 2022).

In a 2019 study involving basketball players, researchers explored the relationship between postural stability, core muscle endurance, and agility (Cengizhan et al., 2019). Consistent with the findings of our study, no significant relationship was observed between core muscle endurance and agility. However, a statistically significant positive correlation was identified between agility and postural stability. This study employed the HOT to evaluate agility.

The HOT is a commonly used field test for measuring agility. In their study, Reiman and Manske reported excellent reliability for the HOT, with Intraclass Correlation Coefficient (ICC) values ranging from 0.86 to 0.95. Since the HOT is a time-based test, shorter completion times indicate greater agility (Reiman & Manske, 2009). Since the HOT is time-based, individuals who complete the test in shorter durations are considered more agile. Nesser et al. examined the connection between balance and agility in football players, reporting a moderate negative correlation between core muscle endurance, assessed via a core endurance test, and agility performance, measured using the pro-agility test (Nesser et al., 2008). In contrast, Sharrock et al. found no significant relationship between core stabilization and athletic performance in male and female collegiate athletes (Sharrock et al., 2011).

Additionally, several studies have explored the effects of static and dynamic core exercises on

athletic performance. For instance, Bayrakdar et al. reported improvements in both agility and speed performance in football players following training programs that incorporated static and dynamic core exercises (Bayrakdar et al,. 2020). However, (Sever, 2018) showed no significant changes in sprint or agility performance parameters in football players after similar core training programs. Moreover, a study conducted by Parkhouse demonstrated that while static and dynamic core exercises improved core endurance, they had no significant impact on performance in field-based fitness tests (Parkhouse & Ball, 2011).

This inconsistency in the literature may be attributed to variability in the accuracy and specificity of the training and exercises administered to athletes. Furthermore, errors in the implementation of both the exercises and the tests themselves could account for these discrepancies. While the direct evidence linking core training and core endurance to athletic performance remains limited, core exercises are a fundamental component of many athletic development programs. However, they are just one subset of the overall training regimen. Isolating the relationship between core muscles and athletic performance is inherently challenging, which may partially explain the conflicting results in the literature.

In contrast, the lack of significant correlation between the double leg lowering test and performance measures may suggest that isolated abdominal strength does not directly translate into improved agility or speed. This aligns with previous studies indicating that core stabilization requires a combination of strength and dynamic control (Haff et al., 2005). Moreover, the results from the back extensions test, which assesses dynamic strength, further underscore the complexity of core stability, suggesting that mere muscle strength may not suffice for enhancing agility or speed (Murphy, 1996).

The observed positive correlation between agility and speed ($r = 0.569$, $p = 0.027$) supports the notion that improvements in agility can directly influence sprinting performance. This finding is in agreement with previous research highlighting the interrelatedness of these performance parameters in basketball (Saeterbakken et al., 2011). The ability to change direction quickly, as demonstrated in the HOT, relies not only on leg strength but also on the effective engagement of core stabilizers to maintain balance and control (Imai &Kaneoka, 2016).

Strenghts and limitations of study

While the current study provides significant insights into the relationships between core stability, agility, and speed in female basketball players, it is essential to acknowledge certain limitations. The limited sample size (n=15) may impact the generalizability of the results. Future studies should involve larger and more diverse populations to confirm these findings and investigate targeted training interventions aimed at improving core stability and athletic performance.

CONCLUSION

In conclusion, this study emphasizes the crucial role of static core stability in improving sprint performance among female basketball players. Furthermore, agility and speed are positively correlated, suggesting that training aimed at enhancing agility may also benefit speed performance. Continued investigation into the dynamics of core stability training and its impact on various performance measures remains necessary to optimize athletic training programs.

Acknowledgement

The authors would like to thank all participants who contributed to the evaluations.

Conflict of Interest

The authors declare that they have no conflict of interest.

Author Contributions

Plan, design: KE, AB; **Material, methods and data collection:** KE, KŞ, TO; **Data analysis and comments:** EK; **Writing and corrections:** KE, AB, KŞ, TO.

Funding

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Approval

Institution: Bandırma Onyedi Eylül University Faculty of Health Sciences Non-Invasive Clinical Research Ethics Committee.
Date: 30.10.2020
Approval no: 2020-41

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