

# The effect of core training on speed, agility, strength and jumping performance in 10-12 year old female badminton players

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## Abstract

### Background and Study Aim

Core training has gained prominence as a crucial component in improving athletic performance, particularly in sports that demand high levels of coordination, balance, and explosive power. Badminton, which requires rapid directional changes, agility, and lower-body strength, may particularly benefit from such training methods. The aim of this study is to determine the effects of a four-week core training program on speed, agility, strength and jumping performance in 10 to 12 year old female badminton players.

### Material and Methods

This study was designed as a pre-test-post-test control group experimental research using quantitative methods. Twenty-two female badminton athletes who participated voluntarily were randomly divided into an experimental group (n = 11) and a control group (n = 11). The experimental group performed a core training program twice a week for four weeks in addition to regular badminton training. The control group performed only regular badminton training during this period. Sprint tests (10 m and 20 m), T agility test, leg strength, hand grip strength, and countermovement jump (CMJ) tests were administered to all participants before and after the training period. The normality of the data was assessed using the Shapiro-Wilk test. Data with normal distribution were analyzed using repeated measures analysis of variance (ANOVA).

### Results

According to the findings, there were no significant differences between the pre-test values of the groups ( $p > 0.05$ ). Over time, significant improvements were observed in the T agility test ( $p = .047$ ;  $\eta^2 = .18$ ) and the CMJ test ( $p = .024$ ;  $\eta^2 = .23$ ). Both results indicated large effect sizes. No significant differences were observed in the 10 m and 20 m sprint, leg strength, or hand grip strength tests ( $p > 0.05$ ). Regarding the interaction between time and group, significant differences were again found in the T agility test ( $p = .045$ ;  $\eta^2 = .19$ ) and the CMJ test ( $p = .014$ ;  $\eta^2 = .26$ ), both indicating large effect sizes. No significant time  $\times$  group interactions were found for sprint, leg strength, or hand grip strength variables ( $p > 0.05$ ).

### Conclusions

The four-week core training program applied to youth female badminton players had positive effects on agility and jumping performance. Based on these results, incorporating core training into the routine practice of youth athletes is recommended to enhance agility and explosive power in sports that require rapid directional changes.

**Keywords:** badminton, speed, agility, strength, core training

## Introduction

Badminton is a popular sport played by approximately 200 million people worldwide in outdoor, garden, or beach environments [1]. Its widespread participation highlights the significance of this sport at both recreational and professional levels. Badminton players must perform fast and precise movements, including sudden changes of direction, jumping, and running under varying conditions. The successful performance of athletes directly depends on their physical fitness levels. Studies have shown that the abdominal muscles provide proximal stability for distal mobility [2]. Sports scientists are increasingly interested in using different training protocols to enhance athletic performance. To improve performance in badminton players, various training methods are

used to develop biomotor abilities, especially in sports where speed, agility, strength, and jumping are essential [3]. Core exercises, which have gained increasing attention from sports scientists in recent years, help develop basic balance in athletes and are applied to enhance overall performance [4]. Core training strengthens the muscle groups primarily responsible for maintaining trunk stability, enabling athletes to improve their balance, posture, and movement control [5].

Badminton is a sport played under physically demanding conditions and at a high level of competition, where athletes require advanced speed, agility, and explosive power. To succeed in this sport, athletes must make quick and timely movements while maintaining strong stability. One of the key factors contributing to success is a strong abdominal region [6]. Strength, speed, and agility are all essential in badminton. Given the influence

of core training on the development of these motor skills, it has become an increasingly important area of focus for researchers. Regular core training in children is known to support the development of basic motor skills and enhance overall performance [7]. Badminton players cover the entire court in a very short time, execute strokes, and return to the center. To reach the area where the opponent hits the shuttle and respond effectively, athletes must possess high levels of strength, speed, and agility. After making a stroke, it is crucial for athletes to return to position in a balanced, fast, and coordinated manner. The legs should be placed shoulder-width apart, and the body should remain oriented toward the opponent's court without swaying to either side. Badminton players must maintain strong stabilization [8].

The word "core" refers to the central part of something. In the human body, the core region is the central area that also contains the body's center of gravity [9]. Core exercises reduce the risk of injuries in the lower extremities and knee joints and help prevent their occurrence. Today, core training is widely used not only to enhance athletic performance but also to minimize injury risk in athletes, improve the physical fitness of sedentary individuals, and support the treatment of patients with back pain [10]. Studies have shown that athletes who include core exercises in their training programs experience improvements in balance, agility, and strength. Increased core strength enables more controlled movements and allows athletes to react more quickly to sudden changes in motion [11, 12]. It is believed that a strong core ensures that the forces generated by the lower extremities are efficiently transferred through the torso to the upper body. Conversely, a weak core may disrupt this energy transfer, reducing sports performance and increasing the risk of injury to distal limbs or underdeveloped muscle groups.

Analysis of previous research results has shown that core training plays a significant role in improving athletic performance by enhancing balance, agility, strength, and injury prevention. Researchers have emphasized the importance of a strong core in supporting the transfer of force between the lower and upper body segments. They also highlight the role of core stability in maintaining postural control and movement efficiency during sports activities. However, despite the growing number of studies on this topic, there remains a clear need for more in-depth investigations, particularly focusing on specific populations such as young athletes. Further research is needed to evaluate the effects of core training protocols on performance parameters in children, where developmental and physiological differences may lead to varied outcomes.

**Hypothesis:** Based on the analysis of previous research findings, it is hypothesized that a four-week core training program will significantly improve

speed, agility, muscular strength and jumping performance in 10 to 12 year old female badminton players.

The aim of this study is to determine the effects of a four-week core training program on speed, agility, strength and jumping performance in 10 to 12 year old female badminton players.

## **Materials and Methods**

### *Participants*

The study group consisted of 22 female badminton athletes aged 10 to 12 years with prior badminton experience in the Tatvan district of Bitlis province, Turkey, who voluntarily agreed to participate in the study. Block randomization was used to assign participants to groups in this pre-test–post-test control group experimental design. Since there were two groups, the block size was set at four, with two participants randomly allocated to each group within each block. A total of six blocks were created, resulting in an equal distribution of 11 participants in each group. To minimize bias, the randomization process was performed by an independent individual who was not part of the research team. Prior to the study, ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Bitlis Eren University (approval date: 02.01.2025; decision number: 16; protocol number: 2024/9). Additionally, the study was conducted in accordance with the Declaration of Helsinki.

### *Research Design*

General information about the study was provided to both the participating athletes and their parents. Detailed explanations were also given regarding the training program to be implemented and the data collection procedures. It was clearly communicated that participation in the study was voluntary, that there was no obligation to participate, and that only athletes who consented voluntarily would be included. A voluntary consent form was obtained from the participating athletes, and a parental consent form was signed by their parents. Athletes with chronic diseases, musculoskeletal injuries, or those requiring regular medication were excluded from the study. Considering the young age of the participants, both athletes and parents were instructed to ensure consistent sleep patterns, maintain regular eating habits, and refrain from using any ergogenic aids or stimulants during the study period. Additionally, during the data collection phase, participants were advised to avoid intense physical activity and abstain from caffeine consumption for 24 hours prior to testing. Alongside their regular badminton training, athletes in the experimental group participated in core strength training for four weeks, two days per week. The control group received only routine badminton training during the same period.

### *Data Collection Tools*

**Countermovement Jump (CMJ) Test.** The CMJ test was used to assess leg strength, jumping ability, and alactacid anaerobic power. Measurements were conducted using a Smart Jump mat (Fusion, Australia), an electronic device designed to record jump height. All athletes were instructed to stand on the mat with their hands placed on their waists. When ready, they performed a maximal vertical jump, landing back on the mat immediately after takeoff. Each athlete was given two trials. Jump heights were recorded in centimeters, and the best result was used for analysis [13].

**5m and 10m Sprint Tests.** Athletes' 5-meter and 10-meter sprint performances were assessed on a polyurethane-coated indoor sports hall floor using a Smart Speed system (Fusion Sport, Australia). The floor was checked to ensure it was dry prior to testing. Photocell timing gates with 0.01-second precision were positioned at both the start and finish lines for each distance. Athletes began the sprint from a standing position 50 cm behind the start line, starting the run when they felt ready. Timing began when the athlete crossed the first gate and ended upon passing through the final gate. Each athlete performed two trials with a three-minute rest interval between attempts. The best time was recorded for analysis.

**Leg-Strength Test.** Leg strength was measured using a back and leg dynamometer (Takei, TKK 5402 model, Japan). Following a five-minute warm-up, athletes positioned their feet on the dynamometer platform with knees bent. With arms extended, backs straight, and bodies slightly leaning forward, they grasped the dynamometer bar with both hands and pulled it vertically upward using maximum effort through their legs. All measurements were conducted using standardized testing procedures.

**Hand Grip Strength Test.** Hand grip strength was measured using a hand dynamometer (Takei, TKK 5101 model, Japan). Participants could be tested in either a standing or sitting position. The dynamometer was adjusted to fit the hand size of each athlete. While the participant's arm remained straight and the shoulder was positioned at an angle of 10 to 15 degrees from the torso, maximal grip strength was measured starting with the right hand. Each participant performed four trials in total — two with the right hand and two with the left hand. Sufficient rest was provided between trials. After each trial, the dynamometer needle was reset before starting the next measurement. All values were recorded, and the best result for each hand was used for analysis. Results were tabulated to compare the strength of the dominant and non-dominant hands. The highest value obtained during the trials was considered the final result.

**T Agility Test.** The T Agility Test, also known as the 5-10-5 shuttle or 20-yard shuttle test, is an effective

method for measuring change-of-direction speed. The test course consists of four cones arranged in a T-shape, as illustrated in Figure 1. At the start command, the participant begins at the starting point and runs straight to cone 1, touching it with the right hand. The participant then performs a lateral shuffle to the left to cone 3, touching it with the left hand, followed by a lateral shuffle to the right to cone 2, touching it with the right hand. After that, the participant returns laterally to cone 1, touching it with the left hand, and then completes the test by running backward to the starting point. The stopwatch is stopped as soon as the participant crosses the starting point. In this study, after full rest, each participant performed two maximal-effort trials, and the best time was recorded for analysis. To ensure data accuracy, timing was conducted using a Smart Speed electronic timing system (Fusion Sport, Australia). A photocell and reflector pair was placed 2 meters apart, with cone 1 positioned between them. The timer started when the participant passed through the photocell and reflector at the beginning and stopped when they passed through the same point again upon completion [14].

### *Training Protocol*

The duration of the core training protocol applied in this study was set at four weeks, in accordance with existing literature. Previous research, particularly involving child and youth athletes, has reported that even short-term training programs lasting four to six weeks can lead to significant improvements in physical performance [10, 15]. It has also been emphasized that short-term core-based training can support neuromuscular development and enhance motor skills [16]. A relatively short but effective duration was chosen to accommodate the limited attention span typical of athletes aged 10 to 12 and to promote consistent participation throughout the program. Therefore, the four-week training period was considered appropriate both in terms of alignment with existing studies and suitability for the developmental characteristics of the target age group.

The core training protocol was implemented for the experimental group two days per week over a period of four weeks (Table 1).

### *Statistical Analysis*

The data were analyzed using the SPSS software package. The normality of the data was assessed using the Shapiro–Wilk test, and all variables were found to be normally distributed ( $p > 0.05$ ). To confirm the suitability of parametric tests, the assumption of homogeneity of variances was evaluated using Levene's test. The results indicated that variances were homogeneous across groups for all variables ( $p > 0.05$ ). Accordingly, parametric tests were employed for both within-group and between-group comparisons. The analysis of normally

distributed data was conducted using repeated measures analysis of variance (ANOVA). Partial eta squared ( $\eta p^2$ ) values were interpreted as follows: small = 0.01, medium = 0.06, and large = 0.16. The significance level was set at 0.05.

**Results**

Descriptive statistics of the general characteristics of the female badminton players who participated in the study are presented in Table 2. The comparison of pre-test values for speed, agility, strength, and jump performance between the experimental and control groups is provided in Table 3.

As shown in Table 2, the experimental and

control groups were similar in terms of age, height, and body mass at baseline. The small differences in mean values between groups were minimal and within acceptable ranges, indicating that the groups were comparable before the intervention.

According to the findings presented in Table 3, there was no significant difference between the pre-test values of the experimental and control groups ( $p > 0.05$ ). Over time, improvements were observed in agility and jumping performance among female badminton athletes following a four-week core training program. In the T agility test, the mean score of the experimental group decreased from  $16.64 \pm 1.61$  seconds in the pre-test to  $15.70 \pm 1.77$  seconds

**Table 1.** Core training protocol

Exercise	Number of Sets (Weeks 0-2)	Number of Sets (Weeks 3-4)	Exercise Duration (sec)	Rest Between Exercises (sec)	Rest Between Sets (sec)
Plank	2	3	20	30	60
Side Plank	2	3	20	30	60
Crunch	2	3	20	30	60
Reverse Crunch	2	3	20	30	60
Superman	2	3	20	30	60
Squat	2	3	20	30	60

**Table 2.** Descriptive statistics of the general characteristics of the participants

General Characteristics	Experimental Group (n = 11)			Control Group (n = 11)		
	$\bar{X} \pm SD$	Min	Max	$\bar{X} \pm SD$	Min	Max
Age (years)	10.91 $\pm$ 0.94	10.00	12.00	10.82 $\pm$ 0.98	10.00	12.00
Height (cm)	139.09 $\pm$ 8.61	126.00	150.00	135.91 $\pm$ 10.79	121.00	151.00
Body Mass (kg)	32.47 $\pm$ 6.65	23.00	44.80	31.52 $\pm$ 6.94	24.65	44.00

Note.  $\bar{X}$  - mean; SD - standard deviation; Min - minimum; Max - maximum

**Table 3.** Comparison of pre- and post-intervention test values

Tests	Group	Pre Test	Post Test	Group		Time		Time*Group	
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	p	$\eta p^2$	p	$\eta p^2$	p	$\eta p^2$
5m Sprint (sec)	CON	1.29 $\pm$ 0.10	1.26 $\pm$ 0.08	.835	.00	.416	.03	.438	.03
	EG	1.28 $\pm$ 0.11	1.28 $\pm$ 0.12						
10m Sprint (sec)	CON	2.34 $\pm$ 0.17	2.34 $\pm$ 0.15	.846	.00	.317	.05	.228	.07
	EG	2.31 $\pm$ 0.18	2.34 $\pm$ 0.17						
T Agility (sec)	CON	16.24 $\pm$ 1.58	16.25 $\pm$ 1.59	.912	.00	.047	.18	.045	.19
	EG	16.64 $\pm$ 1.61	15.70 $\pm$ 1.77						
Leg Strength (kg)	CON	46.27 $\pm$ 11.22	46.77 $\pm$ 10.37	.091	.14	.570	.02	.846	.00
	EG	55.86 $\pm$ 13.58	56.11 $\pm$ 14.72						
Dominant Hand Grip Strength (kg)	CON	14.57 $\pm$ 4.19	15.03 $\pm$ 4.82	.251	.07	.130	.11	.787	.00
	EG	16.48 $\pm$ 3.63	17.13 $\pm$ 3.47						
Non-Dominant Hand Grip Strength (kg)	CON	13.38 $\pm$ 4.27	13.56 $\pm$ 3.38	.415	.03	.142	.11	.361	.04
	EG	14.39 $\pm$ 3.35	15.15 $\pm$ 3.80						
CMJ (cm)	CON	21.61 $\pm$ 4.49	21.52 $\pm$ 3.66	.993	.00	.024	.23	.014	.26
	EG	20.61 $\pm$ 3.14	22.49 $\pm$ 3.92						

Note.  $\bar{X}$  - mean; SD - standard deviation; p - significant value;  $\eta p^2$  - partial eta squared

in the post-test. This change was statistically significant ( $p = .047$ ;  $\eta^2 = .18$ ), indicating a large effect size. Similarly, in the countermovement jump (CMJ) test, the mean score increased from  $20.61 \pm 3.14$  cm in the pre-test to  $22.49 \pm 3.92$  cm in the post-test, with a statistically significant improvement ( $p = .024$ ;  $\eta^2 = .23$ ), also indicating a large effect size. These results demonstrate that core training positively contributes to agility and jumping performance. No significant changes over time were observed in the 5 m and 10 m sprint tests, leg strength, or hand grip strength ( $p > 0.05$ ). Regarding the interaction between time and group, significant differences were identified in both the T agility test ( $p = .045$ ;  $\eta^2 = .19$ ) and the CMJ test ( $p = .014$ ;  $\eta^2 = .26$ ), again indicating large effect sizes. However, no significant time  $\times$  group interaction was found for the 5 m and 10 m sprint tests, leg strength, or hand grip strength ( $p > 0.05$ ).

## Discussion

This study examined the effects of a four-week core training program on speed, agility, strength, and jumping performance in badminton athletes aged 10 to 12 years. Following the training intervention, significant improvements were observed in agility and jumping performance among female participants. The results of the agility and countermovement jump tests suggest that core training is effective in enhancing motor skills relevant to dynamic movement and coordination. Furthermore, the observed effect size values indicate that these improvements were not only statistically significant but also practically meaningful. In contrast, no significant changes were found in sprint performance, leg strength, or hand grip strength. This may imply that short-term core training interventions are more effective for certain components of physical performance, particularly those involving balance, coordination, and neuromuscular control, rather than pure strength or linear speed. Overall, the findings suggest that core training can positively influence agility and jumping ability in young badminton players and may be a valuable component of training programs designed for this age group.

When reviewing studies in the literature that examine the effects of core training on performance, findings similar to those of the present study are frequently observed. Core exercises have been shown to have significant positive effects on postural stability and agility performance [4]. Additionally, core training has been reported to improve jumping ability [16]. These findings align with the current study and support the beneficial role of core training in enhancing dynamic sport-specific movements. In one study investigating the effects of core training on agility, speed, and vertical jump performance in female athletes,

improvements were observed across all parameters in favor of the experimental group [17]. These results support the current findings regarding agility and jumping performance. However, unlike our study, that research also reported improvements in speed performance. This discrepancy may be attributed to the longer duration of the core training program (six weeks) and the older age group of participants (18 to 25 years), which could influence the magnitude and nature of adaptations.

Core training has been shown to enhance athletic performance in various youth populations. For example, its application in young volleyball players resulted in significant improvements in vertical jump and agility in favor of the experimental group [18]. Similarly, in young male football players aged 12 to 13, core exercises were found to increase core muscle mass and improve vertical jump performance [19]. Among athletes aged 8 to 10, core training led to significant enhancements in biomotor performance parameters [20]. In addition, studies involving adolescent participants have reported that core training positively affects agility, vertical jump, and strength outcomes [21]. While these findings collectively support the effectiveness of core training across different youth age groups, it is important to recognize that pre-adolescent athletes possess unique physiological and developmental characteristics. These differences may affect training adaptations, neuromuscular coordination, and recovery processes, and therefore must be considered when designing training interventions for this population.

Several studies have demonstrated that core training has a positive impact on physical performance in athletes across different sports. For instance, core training programs incorporating Pilates-based exercises applied to elite male and female badminton athletes were found to significantly enhance agility, a key component of badminton performance [22]. Similarly, core training in soccer players led to notable improvements in vertical jump, anaerobic power, and agility [23]. In another study, a nine-week core training intervention resulted in significant gains in vertical jump, agility, and speed performance in the experimental group [24]. These findings support the current study's results regarding countermovement jump (CMJ) and agility performance. However, the improvements in speed reported in that study do not align with our findings. This discrepancy may be attributed to the longer duration of the core training program (nine weeks) compared to the four-week program in the present study. Further evidence from studies applying different core training protocols confirmed improvements in vertical jump and agility performance across groups [25]. In badminton players specifically, core training was shown to significantly enhance balance, agility, and strength

[26], while amateur badminton players also exhibited improvements in balance and agility following core exercise interventions [2]. Additionally, a positive correlation between core training and agility in badminton players was identified, suggesting that increased core stability contributes to better agility outcomes [27]. A study involving 65 badminton athletes also reported significant improvements in leg strength and agility after core training [28].

On the other hand, it is noteworthy that core training did not produce significant improvements in speed, leg strength, or hand grip strength in the present study. This suggests that the direct impact of core training on speed-related performance may be limited. Previous research has indicated that core training tends to yield more substantial benefits in movements requiring balance and coordination [29]. In a similar study involving taekwondo athletes aged 10 to 12, significant improvements were observed in agility and jumping performance, while no significant changes were found in speed performance [30]. In this context, the lack of significant changes in strength-related parameters such as speed, leg strength, and hand grip strength may indicate that core training alone is not sufficient to improve these specific components of physical performance. Moreover, it has been emphasized that core training should be tailored to account for individual differences. Research in various sports disciplines has shown that the effects of core training may vary depending on athlete characteristics and sport-specific demands [31]. Therefore, implementing individualized core training programs in sports that rely heavily on agility and jumping, such as badminton, may help achieve more effective and targeted outcomes.

#### *Limitations of the Study*

One of the main limitations of this study is the relatively short duration of the core training intervention, which was limited to four weeks. This restricted the ability to evaluate the long-term effects of core training on athletic performance. Additionally, the study focused exclusively on female badminton players aged 10 to 12 years. As a

result, the generalizability of the findings is limited with respect to other age groups, genders, sports disciplines, and competitive levels.

To gain a more comprehensive understanding of the effects of core training, future studies should incorporate larger and more diverse samples, extended intervention periods, and participants across different developmental stages and skill levels. It is also recommended that methodological adaptations be tailored to the physiological and developmental characteristics of young athletes. These may include individualized training loads, progressive overload strategies adjusted to growth patterns, and age-appropriate exercise selection. Moreover, incorporating longer follow-up periods may be beneficial for assessing the sustainability of training-induced performance adaptations. Such approaches would enhance the scientific validity, practical applicability, and long-term impact of core training programs within youth athletic development frameworks.

## **Conclusions**

This study highlights the relevance of incorporating core training into the physical preparation of young athletes involved in sports that require rapid directional changes and postural control, such as badminton. Core training may serve as a valuable component of long-term athlete development by supporting movement efficiency, coordination, and overall functional capacity. Given the specific developmental needs of pre-adolescent athletes, structured and age-appropriate core training programs can contribute meaningfully to the physical foundation necessary for sport-specific skill acquisition. The integration of such training into regular practice routines offers potential benefits for improving physical literacy and supporting safe, effective athletic progression in youth sport settings.

## **Conflict of Interests**

The authors declare that there are no conflicts of interest related to this study.

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