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Specific change of direction test for badminton players: badminton shuttle run agility test

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Abstract

Background and Study Aim Change of direction speed and agility are typically present in badminton, where players frequently shift direction during short, high-intensity rallies. These actions involve coordination, balance, and movement control while using the racket and shuttlecock. Although various change of direction tests are used in training and evaluation, their relevance to badminton-specific demands remains a subject of practical interest. The aim of this study was to develop a modified change of direction test that simulates rally conditions in badminton using a racket and shuttlecock, without requiring special equipment.

Material and Methods The study included thirty seven male elite and sub elite badminton players (also students). Elite athletes' mean values were (n=21, age: 21.5±1.1 years, height: 179.7±5.1 cm, weight: 70.1±2.2 kg, and years in sport: 9.4±1.4). Sub elite athletes' mean values were (n=16, age: 19.8±1.2 years, height: 176.1±4.1 cm, weight: 66.88±8.94 kg, and years in sport: 8.6±1.1). The badminton specific shuttle run agility test was carried out on a badminton court. The normality of the data distribution, including concurrent validity, construct validity, and test retest reliability, was assessed using the Shapiro Wilk test for each dataset. The data used to assess concurrent validity were normally distributed, even after log10 transformation. The data used to assess construct validity were also normally distributed. Therefore, the paired t test was applied to evaluate differences between the groups that took part in the BSRAT. The data used to assess test retest reliability were not normally distributed. Therefore, reliability was evaluated by comparing BSRAT performance across five test sessions. The intraclass correlation coefficient (2 way random model, ICC for measurements) and paired t test were used. The alpha level was set at .05.

Results For test retest reliability, we used the log10 transformation of the raw data. The obtained ICC was very high (ICC = .89, 95% CI .81–.93). In addition, the paired t test did not show any significant difference between the test and retest performances (P = 0.07). Meanwhile, elite athletes completed the BSRAT in a shorter time than sub elite athletes (16.13±0.24 and 16.64±0.44 seconds, respectively) (P < .000).

Conclusions The findings of this study show that the change of direction test, which has been adjusted to the badminton branch, is a valid and reliable measurement method.

Keywords: badminton, change of direction, performance, agility

Introduction

Agility and rapid changes in direction are frequently observed in racket sports, where players must respond to dynamic and unpredictable conditions. In badminton, these movement patterns are particularly pronounced due to the short duration of rallies, quick transitions, and multidirectional footwork. Effective execution of such movements requires a combination of neuromuscular coordination, postural control, and technical proficiency with the racket and shuttlecock.

Badminton involves repeated movements such as sudden changes of direction (COD), side-stepping, cross-stepping, quick positional adjustments, and jumping, often performed at high speed and within short time intervals [1, 2]. During a rally, athletes typically execute 6 to 12 strokes in 6 to 10 seconds. The intensity of racket actions and stroke frequency demands the ability to accelerate, decelerate, and change direction rapidly [3, 4, 5, 6, 7]. These motor abilities contribute directly to success in competition. Agility and COD play a central role in maintaining coordinated, timely, and efficient movement patterns throughout play [8, 9].

Change-of-direction speed, as one component of agility, is defined as a pre-planned movement that does not require a response to an external stimulus [10, 11]. This capacity is influenced by multiple factors including sprinting speed, lower limb

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strength and power, and neuromuscular attributes [11, 12]. During directional changes, athletes rely on eccentric and concentric muscle actions of the lower extremities to control deceleration and initiate movement in a new direction. The strength and power of the lower limbs are closely associated with sprinting performance [13], and a strong correlation (r = 0.74) has been reported between strength, sprint ability, and COD performance, all of which contribute to the athlete's overall physical profile [14].

Badminton is considered a fast-paced and competitive sport, with players often gaining an advantage by executing quick and precise directional changes [15, 16]. This has led coaches and researchers to pay closer attention to the assessment of agility and COD ability in badminton athletes. A number of sport-specific tests have been developed to evaluate these qualities [17, 18, 19]. Among them are tests with reported validity and reliability, including the Abian Intermittent Recovery Badminton Test (r = 0.88), Badminton Reaction Inhibition Test (r = 0.70), Badminton Agility Field Test (r = 0.88), Badcamp Agility Test (r = 0.86), and the Specific Shuttle Run Test (r = 0.78) [17, 20, 21, 22, 23].

Performance tests are expected not only to detect performance differences between athletes, but also to incorporate skills that are specific to the technical and tactical context of the sport [24]. For example, a player's ability to reposition quickly to the central area after a directional change depends on physical readiness and sport-specific movement skills. Performance tests are often designed to evaluate perceptual and reactive capacities [25]. In one study, badminton players were asked to respond rapidly and accurately to a visual stimulus on a touchscreen, and experienced players showed shorter response times [25]. In another study, a training intervention produced a significant improvement in COD values between pre- and post-test assessments among badminton athletes [26].

Analysis of research findings has shown that various test protocols can effectively measure agility and change of direction in badminton players under controlled conditions. Researchers emphasize that these tests are valuable for evaluating both general movement capacity and sport-specific performance attributes. At the same time, practical challenges such as test complexity, equipment availability, and limited simulation of actual rally conditions may affect their applicability in training environments. These considerations highlight the need for assessments that are both functionally relevant and adaptable to real-game contexts. Therefore, this study aimed to develop a modified change of direction test that simulates rally conditions in badminton using a racket and shuttlecock, without requiring special equipment.

Materials and Methods

Participants

The study included thirty-seven male elite and sub-elite badminton players (also students) (elite and sub-elite players were at least quarter-finalists in national games or athletes at the national team level). The athletes participating in the study were physically healthy and did not have any serious lower-body injuries, such as anterior cruciate ligament (ACL), hamstring, meniscus, or ankle injuries, or any medical or orthopedic problems. All athletes were right-hand dominant and participated voluntarily.

The mean values for elite athletes were (n = 21; age: 21.5 ± 1.1 years; height: 179.7 ± 5.1 cm; weight: 70.1 ± 2.2 kg; years in sport: 9.4 ± 1.4). For sub-elite athletes, the mean values were (n = 16; age: 19.8 ± 1.2 years; height: 176.1 ± 4.1 cm; weight: 66.88 ± 8.94 kg; years in sport: 8.6 ± 1.1).

Before data collection, all participants were informed about the purpose, potential benefits, and possible risks of the study. Written informed consent was obtained from each participant in accordance with the Declaration of Helsinki. The study protocol was approved by the Research Ethics Committee of Karamanoğlu Mehmetbey University (Approval No: 01-2022/11).

Inclusion criteria for the study

- Being an elite or sub-elite badminton player
- Having no physical or mental health problems that would prevent the application of the tests
- Participating in the study voluntarily and having signed the voluntary consent form

Exclusion criteria for the study

- Not being an elite or sub-elite badminton player
- Having any physical or mental health problems that would prevent the application of the tests
- Participating in the study without volunteering or without signing the voluntary consent form

Anthropometric variables

The athletes' body weights were measured using a Gold Master GM-7175R Slim Fit weighing machine with ±100 g sensitivity, and their heights were measured using a Mesilife MC-210 stadiometer with a ±0.5 cm margin of error. The athletes' body mass indices (BMIs) were calculated using the formula: weight (kg) divided by height (m^2) squared.

Testing Setup

The badminton-specific shuttle run agility test (BSRA) was carried out on a rectangular badminton court (13.40 m long and 6.10 m wide). During the test, the BSRA was performed on one half of the court to account for both singles and doubles adaptations. The half-court used for testing measured 6.70 m in length and 6.10 m in width.

Shuttlecocks were placed in seven different directions from a 20 × 20 cm square located at the center of the court. The distances from the center to each shuttlecock were as follows:

P–1: 305 cm,

1–2 Anterior Right Cross (ARC): 453 cm,

1–3 Anterior (A): 335 cm,

1–4 Anterior Left Cross (ALC): 453 cm,

1–5 Right Lateral (RL): 305 cm,

1–6 Left Lateral (LL): 305 cm,

1–7 Right Rear Right Cross (RRRC): 453 cm,

1–8 Left Rear Left Cross (LRLC): 453 cm,

1–P Posterior Back Running (PBR): 305 cm.

The directional layout of the BSRA test is illustrated in Figure 1.

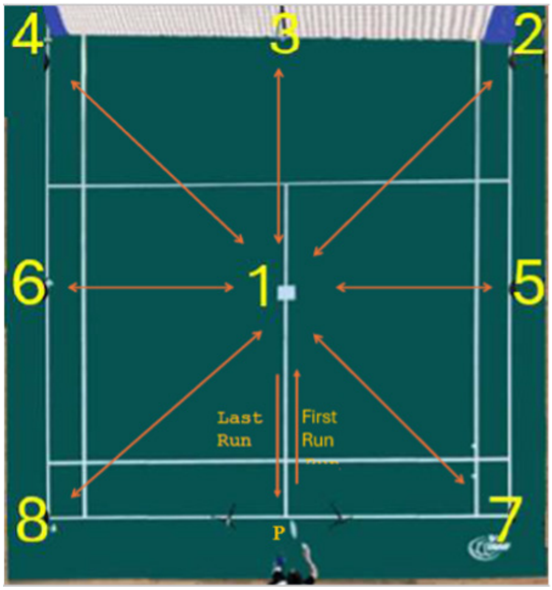

Figure 1. Badminton Shutle Run Agility Test.

Note. Photocell (P) – 1 (Center); 1–2 Anterior Right Cross (ARC); 1–3 Anterior (A); 1–4 Anterior Left Cross (ALC); 1–5 Right Lateral (RL); 1–6 Left Lateral (LL); 1–7 Posterior Right Cross (PRC); 1–8 Posterior Left Cross (PLC); 1–P Posterior Back Running (PBR)

The athletes completed the BSRA test using a badminton racket and shuttlecock that met international standards. The racket length was 680 mm, the head length 230 mm, and the grip diameter 25.4 mm. The photocell device used for the BSRA test was a Microgate Witty Wireless Training Timer (Bolzano, Italy).

The athlete waits behind the photocell with the racket in hand, as shown in Figure 1. When ready, the athlete begins by running to the center spot (point 1). From there, the shuttlecock placed at point 2 is either touched or knocked over using the racket. The athlete then returns to the center and touches the square with one foot before proceeding to point 3. This pattern continues through points 4, 5, 6, and 7. After completing the action at point 8, the athlete returns to point 1, touches the center square again with the foot, and then sprints to the photocell to stop the timer.

The spatial configuration of shuttlecock placement is illustrated in Figure 2.

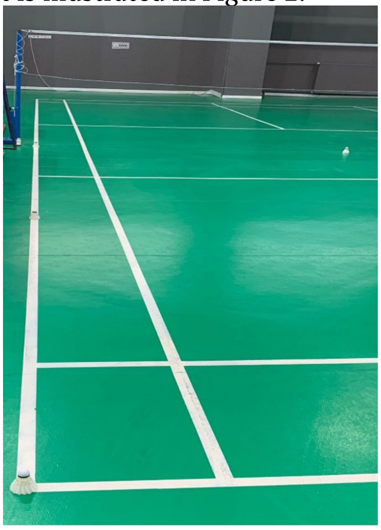

Figure 2. Visual of the balls being placed on the ground

Badminton-Specific Shuttle Run Agility Test (BSRAT)

All athletes performed a general warm-up prior to the test. Participants wore well-fitted, balanced badminton shoes identical to those used in competition. Shoe conditions were checked to ensure appropriate surface grip on the testing floor.

The test protocol was demonstrated step by step by a qualified coach. Each athlete stood one meter behind the photocell with the racket held in their dominant hand, as previously shown in Figure 1. The sequence of movements was the same regardless of whether the racket was held with the right or left hand.

Upon breaking the photocell beam, the athlete initiated the test. After reaching point 1, he contacted the shuttlecock at point 2, then returned to the center and touched the square with one foot before proceeding to each subsequent point (3 to 8). After contacting point 8, the athlete again returned to the center square and completed the test by sprinting toward the photocell to stop the timer. Start and finish lines were located at the same photocell.

Each athlete first completed one familiarization trial, followed by five valid trials. Passive rest intervals of at least five minutes were provided between trials.

The following conditions required test repetition:

a) Performing the route in the wrong order

b) Aborting the test mid-way

c) Deliberately slowing down.

The following actions resulted in time penalties:

a) Failure to touch a shuttlecock: +1 second per error

b) Failure to touch the center square with the foot: +1 second per error.

Validity and Reliability Assessment

The performances of 37 badminton players were assessed to evaluate concurrent validity. The athletes performed the BSRAT on the 1st, 2nd, 3rd, 4th, and 5th days. The test was completed by starting from the initial point, running to the center, contacting the shuttlecock in seven different directions, returning to the center after each attempt, and finishing by stopping the photocell. Each athlete completed three trials, and the best (shortest) time was used for analysis.

In this study, the Shuttle Run Agility Test (SRAT), a change-of-direction (COD) test, was used as a reference, as it has long been considered a gold-standard agility test [17]. However, this test does not account for racket and shuttlecock use during gameplay. To address this limitation, we aimed to replicate the actual competitive environment by integrating movement patterns with the badminton racket and shuttlecock into the test procedure.

To assess construct validity, the performances of all 37 players were compared between two groups. The participants were categorized as elite (n = 21; age: 21.5 ± 1.1 years) and sub-elite (n = 16; age: 19.8 ± 1.2 years) athletes, all of whom competed either on the Turkish national team or at the national elite level.

Statistical Analysis

The normality of data distribution for concurrent validity, construct validity, and test–retest reliability was assessed using the Shapiro–Wilk test. The data used to evaluate concurrent validity remained normally distributed even after log10 transformation. The data used for construct validity analysis were also normally distributed; therefore, a paired t-test was used to compare the performances of the groups participating in the BSRAT.

In contrast, the data used to assess test–retest reliability were non-normally distributed. Accordingly, test–retest reliability was evaluated using both the intraclass correlation coefficient (ICC; two-way random model, ICC for measurements) and the paired t-test. The significance level (alpha) was set at .05.

Results

To evaluate concurrent validity, the mean BSRAT time of elite athletes was 16.13 ± 0.24 seconds, whereas sub-elite athletes recorded a mean time of 16.64 ± 0.44 seconds. This difference was statistically significant (t_{36} = −4.69, p < .001), supporting the discriminative power of the test between performance levels.

A Spearman's rho correlation analysis revealed strong and positive associations between BSRAT performance times and change-of-direction (COD) metrics across repeated trials (r = .954, p < .001; r = .883, p < .001; r = .847, p < .001; r = .825, p < .001). These relationships are visualized in Figure 3, which presents a scatterplot of BSRAT performance times and COD scores.

Test–retest reliability was assessed using log10-transformed data. The intraclass correlation coefficient (ICC) was high (ICC = .89, 95% CI = .81–.93), indicating strong reliability. The paired t-test showed no statistically significant difference between test and retest performance (p = .07), suggesting stability of the measurements. Figure 4 displays the Bland–Altman plot, indicating that most values fell within the limits of agreement and no systemic bias was observed (p = .095). Additionally, Figure 5 shows the linear association between log10-transformed scores across test days.

Descriptive statistics for the five trials are presented in Table 1.

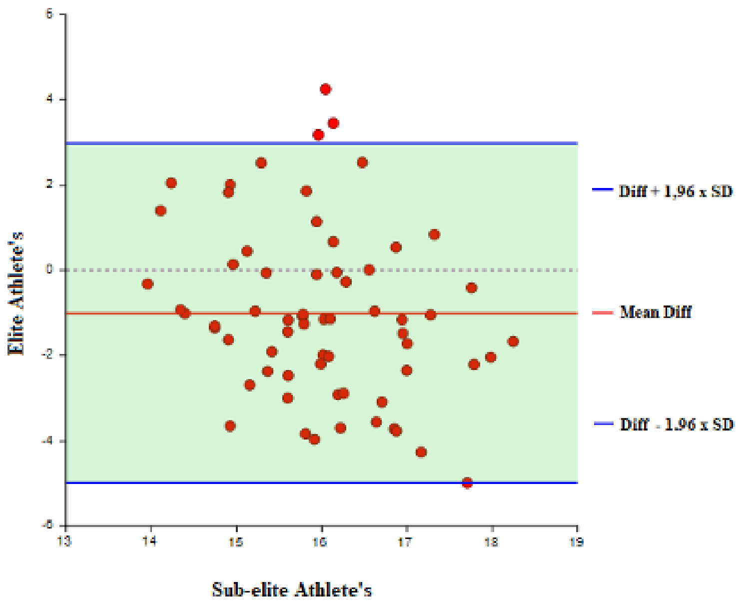

Figure 3. Scatterplot showing correlation between BSRAT and COD performance scores

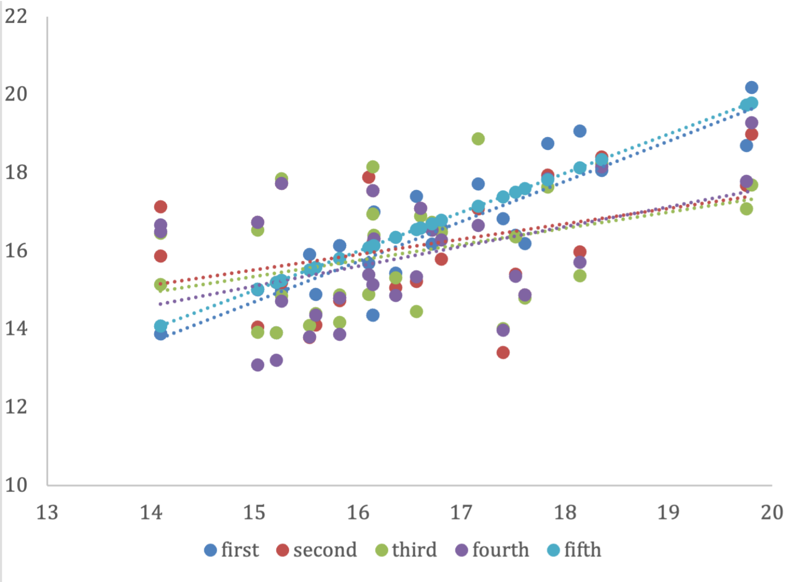

Figure 4. Bland–Altman plot of test–retest BSRAT performance values.

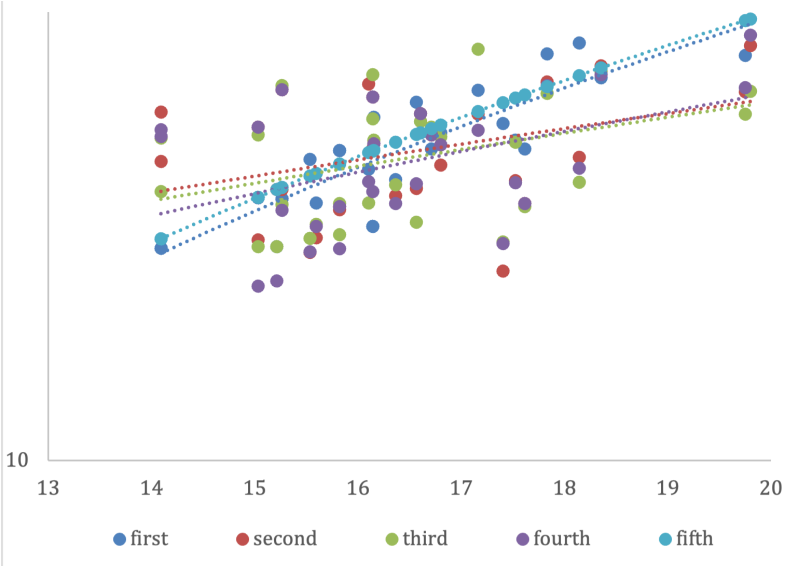

Figure 5. Correlation graph of log10-transformed BSRAT scores across five trials.

Table 1. Mean BSRAT performance values across five trials (N = 37)

Trial	Mean (s)	SD
First Test	16.23	1.66
Second Test	16.11	1.48
Third Test	15.96	1.50
Fourth Test	15.86	1.58
Fifth Test	16.48	1.43

Discussion

This study aimed to assess change-of-direction performance in badminton athletes by incorporating racket handling and shuttlecock interaction into an agility-based testing protocol. The results demonstrated that elite athletes completed the BSRAT in significantly shorter times (16.13 ± 0.24 s) compared to sub-elite athletes (16.64 ± 0.44 s), supporting both the concurrent and construct validity of the test. The observed differences in performance suggest that the BSRAT can differentiate between athlete levels, potentially reflecting variations in movement efficiency, technical execution, and response coordination under sport-specific conditions.

Agility and change-of-direction (COD) speed are often mistakenly treated as interchangeable with linear speed; however, previous research has shown that they represent distinct physical attributes [27]. Sprint-focused training programs do not significantly improve COD performance, and similarly, agility-specific training has minimal effect on linear sprinting speed [28]. These findings suggest that COD and agility should be addressed through targeted and sport-specific conditioning protocols. In the context of badminton, where play is characterized by high-frequency directional changes and reactive movement patterns, agility is a particularly relevant performance factor. The current study confirms this distinction, as BSRAT results differentiated elite from sub-elite players based on movement execution that involved agility-specific tasks rather than linear speed.

Despite this, many existing tests for badminton performance rely on general movement patterns or use non-specific external stimuli that do not reflect the actual demands of match play [17, 20, 22, 29]. Some studies have incorporated sensor-based systems or light cues to simulate reactive scenarios [17, 22], while others have focused exclusively on pre-planned COD performance under time pressure [20, 29]. Several recent publications have introduced test batteries aiming to evaluate agility and directional speed with greater sport specificity [17, 30, 31, 32]. In contrast to these methods, the present study integrated both racket handling and shuttlecock interaction into the BSRAT design, making the test execution more closely aligned with real badminton rallies.

For instance, Torres-Luque et al. [31] developed a test that allows differentiation between match winners and losers by capturing tactical and technical parameters during rallies, demonstrating high reliability (ICC = 0.87). Similarly, the Badcamp Agility Test has shown high concurrent and construct validity as well as test–retest reliability (ICC = 0.93) for badminton players [17]. The Badminton Reaction Inhibition Test (BRIT) has also been validated as a reliable tool for assessing reaction time in athletes and is considered suitable for use in performance-oriented training programs [23]. In addition, studies examining directional acceleration and player load have reported high reliability for COD assessment protocols based on multidirectional movement patterns [33]. Another study that simulated in-game strokes and movement patterns developed a high-validity interval protocol for replicating rally dynamics (ICC = 0.89) [29]. Consistent with these findings, the present study demonstrated that the BSRAT not only achieves high reliability (ICC = 0.89), but also reflects the integrated technical demands of actual match play, making it applicable for both assessment and training purposes.

The findings of this study confirmed that the BSRAT demonstrated high validity and reliability, consistent with previous research on badminton agility assessments [17, 20, 22]. However, the current test protocol includes several distinctive features compared to existing methods that rely on sensors, infrared beams, or stimulus-based equipment.

First, the BSRAT incorporates the use of a badminton racket, which is central to actual in-game performance but often omitted in previous agility studies. Including the racket aligns the test more closely with the technical and biomechanical demands of real match situations.

Second, the test setup is inexpensive and practical, requiring only standard badminton equipment and a court. It does not depend on costly devices or external sponsorship, making it accessible for widespread implementation.

Third, the structure of the BSRAT replicates the rhythm and movement patterns of competitive play. Athletes are required to perform racket-based footwork, return to the center after each directional movement, and execute shuttlecock contacts across the court—mimicking the demands of actual rallies.

As emphasized in previous studies [34], the alignment between test procedures and real-game scenarios is crucial, as performance during simulated match conditions offers more meaningful insight than isolated training metrics.

Unlike closed-skill sports, open-skill sports such as badminton are influenced by constantly changing environmental conditions, including player behavior, match dynamics, and competition demands. Athletes must therefore develop not only the ability to change direction quickly but also to anticipate movement scenarios for optimal performance. Although numerous agilities, sprint, and change-of-direction (COD) tests have been developed for badminton, it is essential that such tests replicate the physical and technical demands of actual match play. The present study demonstrated that the BSRAT is a valid and reliable tool, designed to capture the multifaceted requirements of badminton-specific performance.

The BSRAT protocol developed in this study offers both methodological and practical advantages compared to existing badminton agility tests. While Loureiro and De Freitas [17] reported high test–retest reliability for their COD protocol, their test did not include racket use or simulate stroke-return actions, limiting its sport-specific validity. Van de Water et al. [23] focused on cognitive variables such as visual reaction and decision-making, showing high repeatability and theoretical value. However, their laboratory-based tests lack integration with actual physical demands, reducing ecological validity. Similarly, the AIR-BT test proposed by Abián-Vicén et al. [20] provides useful information on aerobic endurance through incremental loading, but does not fully represent badminton's performance profile, which consists of brief, high-intensity movements with frequent directional changes.

In contrast, the BSRAT integrates technical (racket–shuttle interaction), motor (directional acceleration and deceleration, center return), and procedural (timing, error criteria) elements within a single field-based protocol. This multidimensional structure enhances ecological validity and applicability for both assessment and training. The use of photocell-based timing eliminates manual stopwatch bias, and the inclusion of clear error definitions increases standardization and reduces inter-rater variability. The half-court setup (6.70 × 6.10 m) is suitable for both singles and doubles contexts, supporting its flexibility for applied use. Moreover, its low equipment requirements (a standard racket, shuttlecock, and photocell) make it logistically accessible.

When compared with previous methods, Loureiro and De Freitas [17] provided a simple and reliable protocol for agility, but without technical integration. Van de Water et al. [23] advanced the evaluation of cognitive skills, but without physical context. Abián-Vicén et al. [20] contributed to aerobic capacity testing, though with limited relevance for intermittent rally patterns. Each approach addresses specific performance components. The BSRAT aims to combine technical and motor elements within a game-representative format, offering a practical alternative for agility evaluation in badminton.

Nevertheless, the BSRAT does not measure physiological or pure cognitive variables and should be used alongside complementary assessments to form a comprehensive profile. It is also recommended that the test be administered three times, with the best result used for interpretation, in order to optimize reliability.

Limitations of the Study

This study has several limitations. First, the sample size was relatively small, which may limit the generalizability of the findings. Future studies should include a larger number of participants, particularly at the senior level, to enhance the evaluation of change-of-direction performance and the validity of the protocol. Second, the current research focused exclusively on adult badminton players. Therefore, similar investigations should be conducted with younger athletes of varying age groups and performance levels to assess age-related applicability and scalability of the test.

Further limitations relate to the scope of the BSRAT itself. The test does not include direct measurement of physiological variables such as aerobic or anaerobic capacity (e.g., VO_2max, blood lactate concentration). As a result, test completion time cannot be used to draw conclusions about physiological performance parameters. Additionally, the current version of the protocol does not include a distinct metric for reaction time. The main outcome variable is total completion time, which reflects a combination of technical, physical, and motor skills but does not isolate reactive ability.

To directly assess reaction time, the BSRAT would need to be modified to incorporate randomized visual or auditory stimuli that trigger directional changes. This would allow measurement of reaction-specific variables such as latency from stimulus onset to movement initiation. Without such adaptations, any conclusions about reaction time based on BSRAT results remain indirect and limited.

Conclusions

The results of this study confirm that the Badminton Shuttle Run Agility Test (BSRAT) is a valid and reliable protocol for assessing change-of-direction performance in badminton players. The test incorporates essential technical and motor elements of actual gameplay, such as racket handling, directional changes, and return-to-center movement. Its practical advantages include simple setup, low cost, and ecological validity. Although the BSRAT does not directly measure physiological or reaction-time variables, it can be effectively used as part of a broader performance assessment battery in both training and research contexts.

Acknowledgments

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Conflicts of Interest

The authors declare no conflicts of interest.

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