applied sciences

MDPI

Article

Evaluating Agility in Pre-Adolescent Basketball: A Comparative Analysis of CODAT, IAT, and RAT

Gökhan Deliceoğlu [1], Okan İbiş [1] and Erkan Tortu [2,*]

[1] Department of Coaching Education, Faculty of Sport Sciences, Gazi University, Ankara 06500, Turkey; gokhandeliceoglu@gazi.edu.tr (G.D.); okanibis@gazi.edu.tr (O.İ.)
[2] Department of Coaching Education, Faculty of Sport Sciences, Trabzon University, Trabzon 61335, Turkey
* Correspondence: erkantortu@trabzon.edu.tr; Tel.: +90-554-227-4969

Abstract: Background: In basketball, agility is essential, characterized by the ability to change direction swiftly and accelerate. Traditional tests like the Illinois Agility Test (IAT) and the Reactive Agility Test (RAT) may not fully capture the agility demands specific to basketball. Purpose: This study aimed to introduce the Change of Direction and Acceleration Test (CODAT), designed specifically for young basketball players. It evaluates CODAT's effectiveness by comparing it with IAT and RAT through comprehensive analysis. Methods: We assessed 87 pre-adolescent male basketball players, aged 9 to 13 years, with an average biological age of 11.2 years and an average estimated Peak Height Velocity (PHV) of 12.5 ± 0.5 years, using CODAT, IAT, and RAT. We employed regression analysis and the Bland–Altman method to determine CODAT's reliability and validity. Results: The findings indicate that CODAT offers superior reliability and validity in measuring basketball-specific agility. Consistent scores highlight its potential as an effective tool for agility assessment in basketball training and talent identification. Conclusions: CODAT represents a significant advancement in agility assessment for young basketball players, advocating for its integration into sports science practices to better address the specialized demands of basketball agility.

Keywords: basketball-specific agility; agility testing techniques; youth sports assessment; talent identification; sports training methodologies

Citation: Deliceoğlu, G.; İbiş, O.; Tortu, E. Evaluating Agility in Pre-Adolescent Basketball: A Comparative Analysis of CODAT, IAT, and RAT. *Appl. Sci.* **2024**, *14*, 3815. https://doi.org/10.3390/app14093815

Academic Editors: Gian Mario Migliaccio and Luca Russo

Received: 27 March 2024
Revised: 16 April 2024
Accepted: 20 April 2024
Published: 29 April 2024

1. Introduction

Agility, embodying the synthesis of physical nimbleness and mental sharpness, is essential for excelling in the high-speed, unpredictable environment of basketball. It empowers athletes to swiftly alter direction, control their pace effectively, and adapt to the ever-changing dynamics of a match [1]. This multifaceted trait not only facilitates rapid movements and reactions but also plays a crucial role in boosting player performance and maintaining a competitive advantage on the court [2]. Traditional agility assessments like the Illinois Agility Test (IAT) and the Reactive Agility Test (RAT) have been instrumental but may not fully reflect the unique agility requirements of basketball. The IAT focuses on speed and the ability to navigate a predefined path, testing the athlete's ability to quickly change direction under fixed conditions [3]. However, its applicability to basketball has been questioned due to its lack of sport-specific movements [4]. Conversely, the RAT introduces a reactive component, evaluating an athlete's response to stimuli, which adds a cognitive dimension to agility performance [3]. Yet, despite their usefulness, these tests do not encompass the full spectrum of agility's physical and cognitive demands in basketball contexts. Recognizing these gaps, our research introduces the CODAT, specifically designed for youth basketball players. The CODAT offers a more targeted evaluation by incorporating movements and scenarios that closely mimic in-game situations, thus providing a more relevant measure of basketball-specific agility. Studies have validated the CODAT, demonstrating its superior reliability and sensitivity to basketball's dynamic requirements [5].

A detailed analysis by Wang et al. highlights the critical need to assess both the physical and cognitive dimensions of agility to fully appreciate its contribution to basketball prowess [6]. In response to this, our study also considers the reliability and validity of these tests. The CODAT, IAT, and RAT have undergone rigorous testing to establish their credibility in sports science. For instance, the IAT has shown consistent test–retest reliability and criterion-related validity in various sports settings [7], while the RAT's ability to measure reactive agility has been confirmed through its strong correlation with in-game performance measures [3]. While the IAT and the RAT have been instrumental in laying the groundwork for agility assessment in sports, their scope in addressing the detailed agility demands of basketball is somewhat limited. The IAT focuses on speed and the ability to navigate a predefined path, whereas the RAT evaluates an athlete's response to stimuli, laying a fundamental basis for more specialized assessments.

Emerging from this foundation, the CODAT represents a significant advancement in agility evaluation, tailor-made for basketball, especially targeting the youth demographic. By simulating realistic in-game scenarios, CODAT offers a nuanced assessment that not only encompasses the physical movements but also the contextual decision-making aspects essential in basketball. This approach, as elaborated by Hachana et al., suggests a pivotal shift towards more specific and applicable methods of measuring agility, reflecting the intricate requirements of the sport [7]. The imperative for accurate and dependable measures of agility in basketball, a factor that significantly influences players' performance and their capability to navigate and react to the game's dynamic nature, is irrefutable [8]. With CODAT marking a pivotal step forward in agility testing, it not only proposes a novel benchmark for specificity and application in basketball but also encourages a reassessment of current evaluation practices. This push towards an integrated approach to agility measurement echoes the arguments made by Paul, Gabbett, and Nassis regarding agility's complex role in team sports, suggesting a shift towards more refined and sport-specific assessment strategies [9]. Significantly, our investigation draws upon and extends the findings of previous research that has established the reliability of agility assessments tailored to specific sports demands. References such as Thieschäfer et al. and Krolo et al. have laid the groundwork for understanding the development and assessment of agility in youth sports [10,11]. However, our study extends this knowledge by focusing on the basketball-specific application of CODAT, examining its reliability and validity in comparison to IAT and RAT, and providing new insights into the agility assessment landscape within youth basketball.

The primary aim of this study is to develop and validate a refined measure of agility that resonates with the specific physical and cognitive demands of basketball, particularly for youth players. By introducing the CODAT, this research endeavors to provide a more accurate, reliable, and contextually appropriate tool for evaluating agility in basketball scenarios. This assessment method not only bridges the gap identified in traditional tests like the IAT and the RAT but also aligns with the dynamic and multifaceted nature of basketball, ensuring that the agility metrics are directly applicable to real-game situations. Through this, the study contributes significantly to the sports sciences by enhancing the precision of player evaluation and coaching strategies in basketball, aiming to elevate the overall athletic performance and strategic understanding of young players.

2. Materials and Methods

2.1. Participants

This investigation included 87 male pre-adolescent basketball players from a basketball academy in Ankara, with an average age of 10.83 $\pm$ 1.8 years, a height of 145.6 $\pm$ 10.2 cm, and a weight of 40.5 $\pm$ 8.3 kg. These athletes were selected for their active participation in the academy's training program, which ensured a homogeneous sample representative of the target population for this study. All participants were engaged in a structured training regimen, averaging 5 h per week, which focused on technical skill development, tactical understanding, and physical conditioning specifically designed for pre-adolescent

basketball athletes. The selection was conducted through purposive sampling to include only those athletes who met the study's inclusion criteria, thus ensuring relevance and specificity to basketball agility. The sample size was determined using G*Power analysis, targeting a power of 0.80 and an effect size of 0.30, which indicated a minimum sample size of 85 participants for a multiple regression analysis involving four predictors [12]. This calculation was intended to ensure the representativeness of the sample and the reliability of the study's findings.

The average biological age was determined to be 11.2 years, with consideration given to their Peak Height Velocity (PHV). PHV, an indicator of the speed of growth in height, was estimated using the Mirwald et al. prediction equation [13]. The average estimated PHV for our sample was 12.5 $\pm$ 0.5 years, suggesting that the majority of our participants were in the pre-PHV stage, indicative of their pre-adolescent status. Inclusion criteria included athletes who were engaged in regular basketball training and competition, demonstrating a commitment to improving basketball-specific skills, particularly agility. Exclusion criteria were athletes with recent injuries or health conditions that could affect their performance in agility tests, as well as those outside the specified age range or not regularly participating in basketball training. Given the participants' age, informed consent was obtained from all subjects involved in the study, as well as from their parents or legal guardians. This dual consent process ensured adherence to ethical guidelines for research involving minors, protecting their rights and well-being throughout the study's duration.

2.2. Study Design

The study was designed as a cross-sectional and correlational analysis, utilizing quantitative methodologies to evaluate field performance and screening tests. Ethical clearance was granted by the Gazi University Ethics Committee (Research Code: 2023-E-77082166-604.01.02-837296), approving the study's protocol. The agility assessments included the RAT, the IAT, and the CODAT. A 10 min preliminary warm-up session was conducted prior to the tests to ensure participants were familiar with the procedures. The Witty SEM photoelectric system (Microgate, Bolzano, Italy) was used to record the outcomes of the agility tests. Participants began their trials just behind the starting photocell and initiated movement at the sound of an auditory cue. Timing started as they crossed the starting photocell and stopped upon crossing the finishing line. Adequate rest intervals were provided between tests to allow for recovery and a reduction in heart rates. Figure 1 illustrates the experimental design.

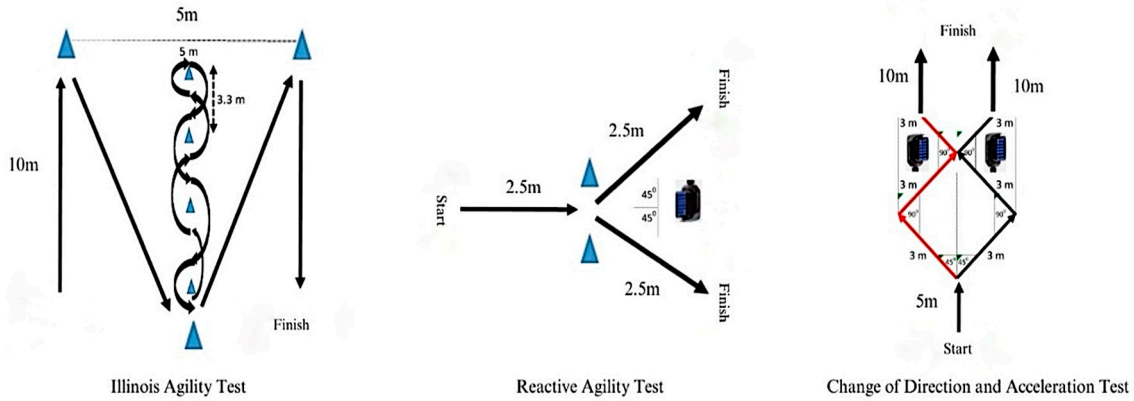

Figure 1. Test protocols.

2.3. Randomization and Fatigue Management

The sequence of agility tests (CODAT, IAT, and RAT) was randomized for each participant to minimize order effects. Randomization was facilitated through a computer-generated sequence. Each participant was assigned a unique identifier, and the software determined the order of the tests accordingly. This method ensured an equal distribution of test sequences among participants. To address potential fatigue, rest intervals were

standardized at 10 min between tests to allow for full recovery. This duration was selected based on preliminary trials, which indicated that it provided sufficient time for participants' heart rates to return to near-baseline levels, thus optimizing their readiness for subsequent tests. The impact of fatigue on performance was further mitigated by limiting the number of trials per session and by monitoring participants for signs of fatigue. Test sessions were scheduled early in the day, following a rest day from regular training activities, to ensure that participants were in peak physical condition.

2.4. Test Administration and Environment

The tests were conducted on an indoor basketball court with a standardized surface to replicate typical playing conditions. Each testing session commenced with a structured 10 min warm-up designed to mirror the athletes' regular pre-game preparations. This warm-up included dynamic stretching, light jogging, and specific agility drills aimed at activating the relevant muscle groups and cognitive pathways. The agility tests were administered by a team of experienced sports scientists and coaches from Gazi University who specialize in basketball training and performance analysis. Instructions for each test were standardized and demonstrated to each participant to ensure clarity and consistency in performance. The Witty SEM photoelectric system (Microgate, Bolzano, Italy) was employed for precise timing of the tests.

2.5. Reactive Agility Test (RAT)

The RAT, designed to evaluate cognitive attributes such as perception and decision-making, involved a 45° directional change over a distance of 5 m. A visual stimulus (light) signaled the direction change. Athletes awaited an auditory cue before starting, then proceeded through a 2.5 m gate before executing a 45° turn towards the indicated direction (light photocell), concluding the test as they passed the final photocell [3].

2.6. Illinois Agility Test (IAT)

The IAT, known for its comprehensive layout, involves navigating a 5 by 10 m course marked with cones placed at 3.3 m intervals. Participants start with a 10 m dash upon receiving an auditory signal, perform a sharp 180° turn, then continue with a 40 m sprint, followed by a 20 m slalom through the cones. The course's completion time is recorded at the end [4].

2.7. Predicted and Unpredicted Change of Direction and Acceleration Test (CODAT)

The CODAT protocol features both Predicted and Unpredicted variants. Both begin with an initial 5 m straight dash, followed by a series of 45° and 90° turns, and conclude with a 10 m sprint. The Unpredicted CODAT variant differs by signaling the direction of turns through visual cues (light photocell) after the initial dash. In contrast, the Predicted CODAT informs participants of the turn sequence beforehand [14].

3. Statistical Analysis

Upon completion of the descriptive statistical assessment of all variables, the Shapiro–Wilk test was utilized to confirm the assumption of normal data distribution. To investigate the predictive ability of various agility tests on CODAT scores among basketball players, a multiple regression analysis was conducted. This analysis included the IAT, the RAT, the Predicted CODAT left side, and the Unpredicted CODAT scores as independent variables, aiming to understand their collective impact on the Predicted CODAT (right side) scores. Subsequently, an assessment of the within-session reliability for each agility test was undertaken, focusing on the calculation of descriptive statistics, specifically the mean, standard deviation, and coefficient of variation (CV%) [15,16]. These statistics provided insight into the consistency of test measures within the same session, with the CV% offering a normalized measure of score dispersion relative to the mean, thereby indicating the reliability of each test. The statistical evaluation of agility tests and change of direction

ability was conducted using the Bland–Altman method to assess agreement between different measurement methods. The analysis focused on comparisons between the IAT and both predicted and unpredicted CODAT, as well as the RAT against predicted and unpredicted CODAT. The analysis of the data was performed with the aid of the Statistical Package for the Social Sciences (SPSS) Version 21.0, developed by IBM Corp., Armonk, NY, USA. A significance level was set at $p \leq 0.05$.

4. Results

In our comprehensive analysis of agility performance among pre-adolescent basketball players, we observed a range of outcomes across different agility tests. As depicted in Table 1, the descriptive statistics provide a broad overview of participants' performances in the IAT, RAT, and both variants of the CODAT. Notably, the standard deviation and Intraclass Correlation Coefficient (ICC) values suggest varying levels of consistency and reliability across these assessments. Further, our regression analysis, detailed in Table 2, explores the predictive power of traditional agility tests (IAT and RAT) and the Predicted CODAT on the outcomes of the Unpredicted CODAT. This analysis reveals significant predictors of performance, underscoring the complexity of agility in sports settings. Specifically, the IAT and Predicted CODAT left side emerge as substantial factors influencing agility, pointing to the integral role of both physical dexterity and cognitive processing in unpredictable agility scenarios. Moreover, the Bland–Altman analyses, illustrated in Figure 2, allow us to examine the agreement between these agility tests more closely. This visual representation highlights the systematic differences and variability between our measures, providing insight into the unique dimensions each test captures regarding an athlete's agility.

Table 1. Descriptive statistics of agility test scores.

Agility Tests	Minimum (s)	Maximum (s)	Mean (s)	Std. Deviation	Coefficient of Variation (CV%)	Intraclass Correlation Coefficient (ICC)
IAT	16.100	29.170	20.211	2.428	12.01	0.80
RAT	1.560	2.580	1.869	0.196	10.51	0.85
Predicted CODAT (right side)	6.750	11.050	8.148	0.861	10.57	0.85
Predicted CODAT (left Side)	5.960	9.950	7.363	0.834	11.33	0.82
Unpredicted CODAT	6.140	11.100	7.667	1.071	13.97	0.75

As depicted in Table 1, in the analysis of agility test performance, descriptive statistics revealed distinct patterns across various tests: IAT scores ranged broadly from 16,100 to 29,170, with a mean score of 20,211 and a standard deviation of 2428. This substantial spread of scores indicates a diverse level of agility among participants, with a distribution that may be slightly left-skewed, as reflected by the mean being closer to the upper end of the range. The RAT presented a more consistent set of performances, as evidenced by the smallest standard deviation of 196. The scores were clustered between 1560 and 2580, with an average score of 1869. The mean score leaning towards the lower end suggests a potentially right-skewed distribution of performances. Regarding the Predicted CODAT for the right side, the minimum and maximum scores were 6750 and 11,050, respectively, with an average score of 8148 and a standard deviation of 861. This test showed moderate variability in scores, indicating a reasonable level of consistency in participant performance with a relatively symmetrical distribution. The Predicted CODAT left side displayed a range from 5960 to 9950 and an average of 7363, paired with a standard deviation of 834. The results implied a slightly right-skewed distribution, suggesting a tendency towards lower scores for participants in this agility measure. Finally, the Unpredicted CODAT showed the greatest variability among the CODAT measures, with a standard deviation of 1071. Scores spanned from 6140 to 11,100, centering around a mean of 7667. The spread of scores suggests that this test may have been less predictable for participants, thus leading

to a wider range of performances. The CV% serves as a critical indicator, highlighting the relative variability of test outcomes. The IAT and RAT, with CV% values of 12.01% and 10.51%, respectively, exhibit moderate variability, suggesting a satisfactory level of reliability for these well-established measures. Similarly, the Predicted CODAT (right side) and Predicted CODAT (left side) demonstrate comparable levels of variability (CV% of 10.57% and 11.33%, respectively), indicating their effectiveness in capturing consistent performance metrics in agility assessment. The Unpredicted CODAT, with a slightly higher CV% of 13.97%, still falls within an acceptable range, though it suggests a marginally increased variability that could be attributed to the test's unpredictable nature, potentially introducing a higher level of challenge for the participants. The ICCs for the agility tests demonstrate moderate to high reliability (ICC range: 0.75 to 0.85), indicating consistent measurement across subjects. Specifically, the RAT and Predicted CODAT (right side) exhibit the highest reliability (ICC = 0.85), affirming their robustness in assessing agility in pre-adolescent basketball players. The slightly lower ICC for the Unpredicted CODAT (0.75) suggests the variability inherent to unpredicted scenarios, yet it confirms its reliability for measuring agility under such conditions. These ICC values, alongside corresponding CV% figures, validate the agility tests' efficacy and consistency in this study's context.

Table 2. Multiple Regression Analysis Summary.

Variable	Coefficient	Std. Error	t	$p > \|t\|$	95% Confidence Interval
Const	0.4925	0.2792	1764.000	0.082546	(−0.0653. 1.0503)
IAT	0.1425	0.0278	5118.000	0.000003	(0.0869. 0.1981)
RAT	0.4741	0.1840	2577.000	0.012279	(0.1066. 0.8416)
Predicted CODAT (left Side)	0.5352	0.1052	5086.000	0.000003	(0.3250. 0.7454)
Unpredicted CODAT	−0.0046	0.0570	−0.081	0.935695	(−0.1185. 0.1093)

Note: 't' represents the t-statistic from the regression analysis, indicating the number of standard deviations a coefficient is away from zero. '$p > |t|$' denotes the p-value associated with this t-statistic, reflecting the probability of observing such an extreme value under the null hypothesis.

As shown in Table 2, the regression analysis conducted aimed to determine the predictive power of various agility tests, including IAT, RAT, Predicted CODAT (left side), and Unpredicted CODAT, on the Predicted CODAT (right side) scores of basketball players. The analysis revealed that the model explains a substantial portion of the variance in Predicted CODAT (right side) scores, as indicated by an R-squared value of 0.937. This high level of explained variance suggests that the model is highly effective in predicting the outcome variable based on the independent variables included. The coefficients indicate the degree of impact each independent variable has on the Predicted CODAT (right side) scores. Specifically, the IAT (coefficient = 0.1425, $p < 0.001$), RAT (coefficient = 0.4741, $p = 0.012$), and Predicted CODAT (left side) (coefficient = 0.5352, $p < 0.001$) were found to be statistically significant predictors of Predicted CODAT (right side) scores. These results suggest that improvements in these agility test scores are associated with better performance in the Predicted CODAT (right side), highlighting their relevance in assessing agility in basketball players. Conversely, the Unpredicted CODAT did not emerge as a significant predictor (coefficient = −0.0046, $p = 0.936$), indicating that its scores do not significantly influence the Predicted CODAT (right side) scores within the context of this model. This finding may suggest that the unpredictability component measured by the Unpredicted CODAT does not significantly affect the specific agility aspect captured by the Predicted CODAT (right side).

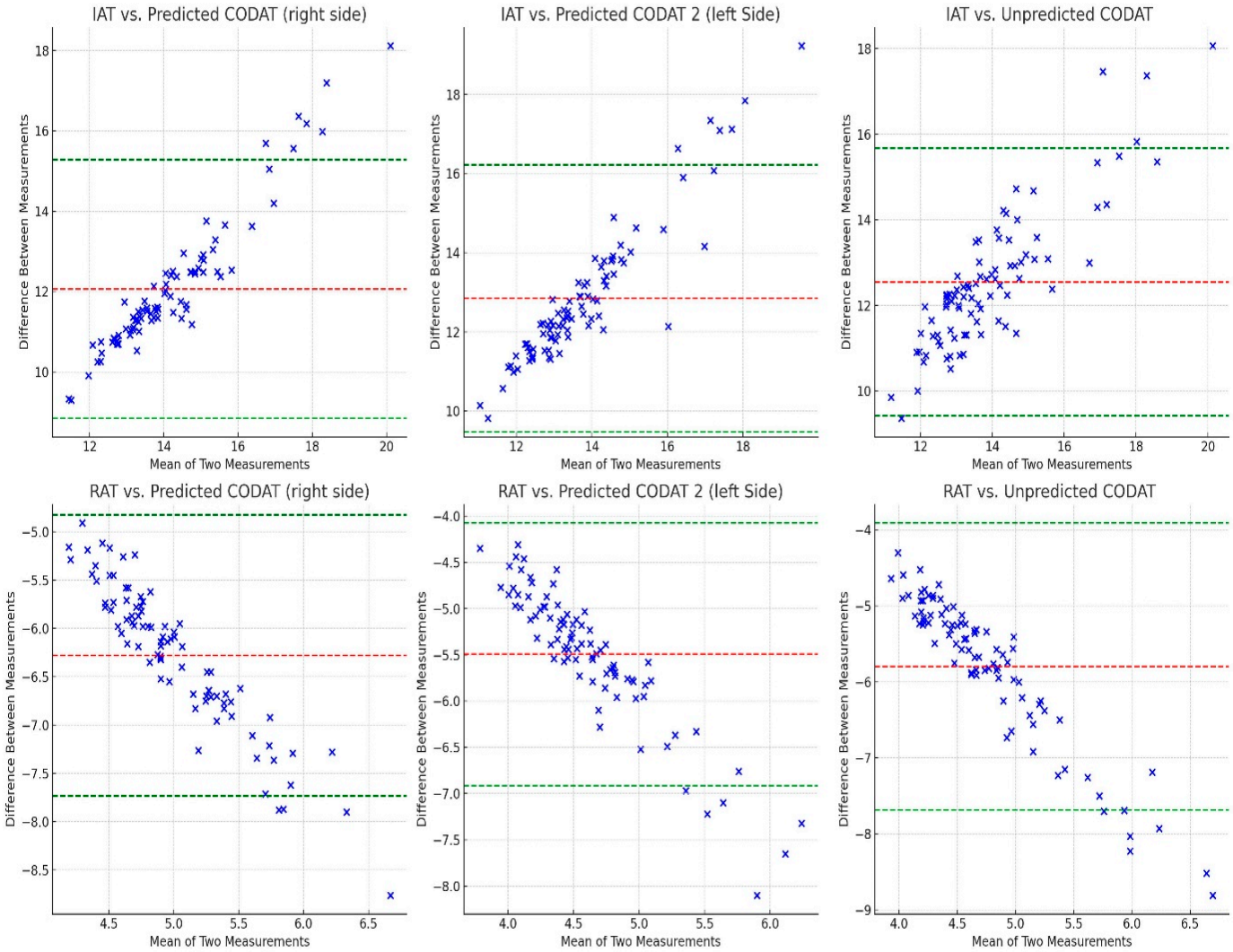

Figure 2. Bland–Altman analyses.

Figure 2 illustrates the mean differences and limits of agreement between IAT and both predicted and unpredicted CODAT, indicating Bland–Altman analyses revealed a mean difference of 12.06 milliseconds (ms) between the Illinois Agility Test (IAT) and Predicted CODAT (right side), with limits of agreement ranging from 8.83 ms to 15.3 ms. For the IAT compared with Predicted CODAT (left side), the mean difference was 12.85 ms, and the limits of agreement were between 9.46 ms and 16.24 ms. The comparison between the IAT and Unpredicted CODAT showed a mean difference of 12.54 ms, with limits of agreement from 9.4 ms to 15.69 ms. For the Reactive Agility Test (RAT) against Predicted CODAT (right side), the mean difference was −6.28 ms, with limits of agreement from −7.74 ms to −4.82 ms; RAT compared with Predicted CODAT (left side) exhibited a mean difference of −5.49 ms, with limits of agreement ranging between −6.92 ms and −4.07 ms; and RAT compared with Unpredicted CODAT presented a mean difference of −5.8 ms, with limits of agreement from −7.7 ms to −3.9 ms. These findings indicate the presence of systematic differences and variability between agility and change of direction ability tests and CODAT measurements.

5. Discussion

This study's findings highlight significant distinctions between the predicted and unpredicted Change of Direction and Acceleration Test (CODAT) in terms of reliability and the physical and cognitive demands they assess. The Intraclass Correlation Coefficient (ICC)

values indicate that the predicted CODAT exhibits slightly superior reliability compared to the Illinois Agility Test (IAT). This suggests that the predicted CODAT, with its structured and pre-defined movement patterns, offers a consistent and reliable measure of physical agility under controlled testing conditions. Conversely, the unpredicted CODAT, which involves elements of unpredictability and decision-making akin to real-game scenarios, shows greater variability in performance (ICC = 0.75). This may reflect the integration of cognitive components such as reaction time and spontaneous strategic decision-making, which are crucial under competitive conditions but lead to increased performance variability. The unpredicted CODAT's lower reliability underscores its sensitivity to cognitive factors, which is not as heavily weighted as the predicted CODAT. These results suggest that the unpredicted CODAT is not just a test of physical agility but also of cognitive agility, making it an essential tool for evaluating an athlete's ability to cope with in-game unpredictability. The distinct demands of these tests highlight the necessity for agility assessments that incorporate both planned and reactive elements to fully prepare athletes for the complexities of competitive sports environments.

This research aimed to assess the effectiveness of the CODAT compared to the IAT and the RAT in evaluating agility among pre-adolescent basketball players. The results indicate that CODAT not only offers superior reliability but also more accurately mirrors the specific agility requirements of basketball. This supports and expands upon the narrative presented in recent studies [17,18]. Contrary to Hachana et al. [7], who emphasized the general applicability of IAT, our findings propose that CODAT delivers a more detailed analysis of agility needs specific to basketball by incorporating aspects of direction change and acceleration, highlighting agility's vital importance in sports as discussed by Paul and Gabbett [9]. The differentiation between the two tests has substantial implications for agility training programs. Training regimens that emphasize both predicted and unpredicted agility components are likely to offer more comprehensive benefits, enhancing both the physical agility required to execute known patterns and the cognitive agility needed to respond to dynamic game situations. Integrating both testing modalities could provide coaches and trainers with deeper insights into an athlete's agility profile, enabling targeted improvements that are likely to translate into better in-game performance.

The agility assessment landscape within youth sports, particularly basketball, has long recognized the need for specificity and reliability in testing protocols. The introduction of CODAT represents a significant stride towards meeting these demands. Our study corroborates the findings of Lockie et al. [18], who highlighted CODAT's high reliability (ICC = 0.84) and its correlation with established agility tests. Similarly, Fessi et al. [17] emphasized the reliability and validity of tailored agility assessments in sports, reinforcing the potential of CODAT as a sport-specific tool for young athletes. Notably, our analysis extends the conversation by demonstrating CODAT's unique applicability to basketball, a contribution not explicitly explored in previous studies. By integrating movements and scenarios closely mimicking in-game situations, CODAT offers an innovative approach to agility evaluation, distinct from the more generalized measures provided by IAT and RAT [7,8].

Recent reviews and studies have emphasized the diversity and evolution of Change of Direction Speed (CODS) tests in basketball, noting a significant increase in test varieties and adoption rates in recent years. For example, a systematic review highlighted the progression from primarily using defensive and 180°-turn types of tests to incorporating cutting types, reflecting more closely the agility requirements of basketball. Notably, the shift towards including reactive tests, which require decision-making in response to external stimuli, marks a significant development in assessing agility more aligned with in-game scenarios [19]. Moreover, research focusing on predictors of speed and agility in youth basketball players has revealed that physical attributes such as countermovement jump and drop jump performance are significant predictors of sprint and agility outcomes [20,21]. Interestingly, body fat percentage emerged as a predictor across all age groups, underscoring the importance of body composition for agility and speed performance [21]. These findings suggest

that agility assessments like CODAT need to consider the multifaceted nature of agility, incorporating both physical and cognitive elements, to accurately evaluate performance.

Research indicates that targeted training programs, notably compound training, have a notable impact on enhancing performance in CODAT, underscoring the value of specialized agility and strength training in elevating basketball players' agility test scores. This underlines the significance of integrating training routines focused on agility to augment results in assessments such as CODAT, which, in turn, positively affects in-game agility and overall performance [22]. Integrating the insights from our study with those of Trecroci, A. et al., 2020, we delve into the effects of compound training on young novice soccer players, focusing on enhancements in sprint, change of direction, and vertical jump performances. The numerical results from Trecroci et al., showing significant improvements in these areas, align with our findings on the effectiveness of CODAT in young basketball players [22]. This underlines the significance of integrating training routines focused on agility to augment results in agility assessments such as CODAT, which, in turn, reflect positively on in-game agility and overall performance. These observations are based on cross-sectional data collected at a single time point, providing a snapshot of the capabilities and effectiveness of CODAT in assessing agility without suggesting longitudinal improvement.

Although the present investigation sheds light on the efficacy of CODAT for young basketball athletes, forthcoming research endeavors ought to traverse various paths. Embarking on longitudinal analyses that evaluate the influence of specialized agility training on CODAT outcomes may furnish proof of the test's responsiveness to training-induced modifications [23–25]. Further examination into how CODAT scores might predict actual in-match performance could solidify its value in competitive scenarios. Broadening the scope of the study to encompass participants of diverse ages and proficiency stages will also enrich our comprehension of CODAT's versatility and relevance throughout the basketball developmental continuum. The study by Stojanovic, E. et al. examines the reliability, usefulness, and factorial validity of six basketball-specific change-of-direction speed (CODS) tests among elite adolescent male basketball players. Results indicated acceptable reliability (ICC: 0.50–0.88, CV: 5.1–7.9%) and a principal component analysis identifying a significant component explaining 74% of the variance. Guards demonstrated superior performance compared to forwards and centers, emphasizing the importance of position-specific CODS. In our study, we extend the findings of Stojanovic, E. et al., examining the reliability, usefulness, and factorial validity of basketball-specific change-of-direction speed tests. Our results, which identify significant enhancements in performance through tailored training, align with their findings, demonstrating the efficacy of agility assessments in improving athletic capabilities.

Although our results offer promising insights, it's essential to consider the limitations of our study. The confined sample size and the focus solely on pre-adolescent male basketball players may restrict the broader applicability of our findings. To ensure the relevance of CODAT across various demographic groups within basketball and potentially other sports, future studies should include participants of a wide array of ages and abilities. Future research directions suggested by our study include conducting longitudinal investigations to evaluate the effect of agility-focused training regimens on CODAT scores, which would illuminate the test's capacity to detect training-induced improvements. Additionally, examining the correlation between CODAT scores and actual game performance could enhance our understanding of the test's predictive value for real-world athletic success [25].

6. Conclusions

In consideration of the findings from this study, the CODAT shows promise as a useful tool for agility assessment within basketball contexts. While the results suggest that CODAT may enhance understanding and the development of agility training programs, it is imperative to recognize that these conclusions are preliminary. The study supports CODAT's potential utility in sports science, particularly for basketball, but additional

research is necessary to fully establish its influence on training methodologies across a broader athletic spectrum. Therefore, we propose that further investigations are warranted to explore CODAT's effectiveness in varied training environments and among different athlete populations to validate its role in sports science comprehensively.

Author Contributions: Conceptualization, G.D. and O.İ.; methodology, G.D., O.İ. and E.T.; validation, G.D., O.İ. and E.T.; formal analysis, G.D. and O.İ.; investigation, G.D. and O.İ.; resources, G.D., O.İ. and E.T.; data curation, G.D., O.İ. and E.T.; writing—original draft preparation, G.D., O.İ. and E.T.; writing—review and editing, G.D., O.İ. and E.T.; visualization, E.T.; supervision, E.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Gazi University Ethics Committee (Research Code: 2023-E-77082166-604.01.02-837296). Approval date: 28 December 2023.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Acknowledgments: The author thank the athletes who participated in this study.

Conflicts of Interest: The author declares no conflicts of interests.

References

1. Horníková, H.; Zemková, E. Determinants of Y-Shaped Agility Test in Basketball Players. *Appl. Sci.* **2022**, *12*, 1865. [CrossRef]
2. Jakovljevic, S.T.; Karalejic, M.S.; Pajic, Z.B.; Macura, M.M.; Erculj, F.F. Speed and agility of 12-and 14-year-old elite male basketball players. *J. Strength Cond. Res.* **2012**, *26*, 2453–2459. [CrossRef] [PubMed]
3. Sheppard, J.; Young, W.B.; Doyle, T.; Sheppard, T.; Newton, R.U. An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. *J. Sci. Med. Sport* **2006**, *9*, 342–349. [CrossRef] [PubMed]
4. Born, D.-P.; Zinner, C.; Düking, P.; Sperlich, B. Multi-directional sprint training improves change-of-direction speed and reactive agility in young highly trained soccer players. *J. Sports Sci. Med.* **2016**, *15*, 314–319. [PubMed]
5. Lockie, R.G.; Murphy, A.J.; Jeffriess, M.D.; Callaghan, S.J. Step Kınematıc Predıctors of Short Sprınt Performance in Fıeld Sport Athletes. *Serbian J. Sports Sci.* **2013**, *7*, 71.
6. Wang, P.; Shi, C.; Chen, J.; Gao, X.; Wang, Z.; Fan, Y.; Mao, Y. Training methods and evaluation of basketball players' agility quality: A systematic review. *Heliyon* **2024**, *10*, E24296. [CrossRef] [PubMed]
7. Hachana, Y.; Chaabène, H.; Nabli, M.A.; Attia, A.; Moualhi, J.; Farhat, N.; Elloumi, M. Test-retest reliability, criterion-related validity, and minimal detectable change of the Illinois agility test in male team sport athletes. *J. Strength Cond. Res.* **2013**, *27*, 2752–2759. [CrossRef]
8. Negra, Y.; Chaabene, H.; Hammami, M.; Amara, S.; Sammoud, S.; Mkaouer, B.; Hachana, Y. Agility in young athletes: Is it a different ability from speed and power? *J. Strength Cond. Res.* **2017**, *31*, 727–735. [CrossRef]
9. Paul, D.J.; Gabbett, T.J.; Nassis, G.P. Agility in team sports: Testing, training and factors affecting performance. *Sports Med.* **2016**, *46*, 421–442. [CrossRef]
10. Thieschäfer, L.; Büsch, D. Development and trainability of agility in youth: A systematic scoping review. *Front. Sports Act. Living* **2022**, *4*, 952779. [CrossRef]
11. Krolo, A.; Gilic, B.; Foretic, N.; Pojskic, H.; Hammami, R.; Spasic, M.; Uljevic, O.; Versic, S.; Sekulic, D. Agility testing in youth football (soccer) players; evaluating reliability, validity, and correlates of newly developed testing protocols. *Int. J. Environ. Res. Public Health* **2020**, *17*, 294. [CrossRef] [PubMed]
12. Faul, F.; Erdfelder, E.; Lang, A.-G.; Buchner, A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* **2007**, *39*, 175–191. [CrossRef] [PubMed]
13. Mirwald, R.L.; Baxter-Jones, A.D.; Bailey, D.A.; Beunen, G.P. An assessment of maturity from anthropometric measurements. *Med. Sci. Sports Exerc.* **2002**, *34*, 689–694. [CrossRef] [PubMed]
14. McNicholas, K.; Comyns, T.M. Attentional focus and the effect on change-of-direction and acceleration performance. *J. Strength Cond. Res.* **2020**, *34*, 1860–1866. [CrossRef] [PubMed]
15. Hopkins, W.G. Measures of reliability in sports medicine and science. *Sports Med.* **2000**, *30*, 1–15. [CrossRef] [PubMed]
16. Atkinson, G.; Nevill, A.M. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Med.* **1998**, *26*, 217–238. [CrossRef] [PubMed]
17. Fessi, M.S.; Makni, E.; Jemni, M.; Elloumi, M.; Chamari, K.; Nabli, M.A.; Padulo, J.; Moalla, W. Reliability and criterion-related validity of a new repeated agility test. *Biol. Sport* **2016**, *33*, 159–164. [CrossRef]

18. Lockie, R.G.; Schultz, A.B.; Callaghan, S.J.; Jeffriess, M.D.; Berry, S.P. Reliability and validity of a new test of change-of-direction speed for field-based sports: The change-of-direction and acceleration test (CODAT). *J. Sports Sci. Med.* **2013**, *12*, 88. [PubMed]
19. Sugiyama, T.; Maeo, S.; Kurihara, T.; Kanehisa, H.; Isaka, T. Change of direction speed tests in basketball players: A brief review of test varieties and recent trends. *Front. Sports Act. Living* **2021**, *3*, 645350. [CrossRef]
20. Fernandez-Fernandez, J.; Loturco, I.; Hernández-Davó, J.L.; Nakamura, F.Y.; García-Tormo, V.; Álvarez-Dacal, F.; Martinez-Maseda, J.; García-López, J. On-court change of direction test: An effective approach to assess COD performance in badminton players. *J. Hum. Kinet.* **2022**, *82*, 155–164. [CrossRef]
21. Čaušević, D.; Čović, N.; Abazović, E.; Rani, B.; Manolache, G.M.; Ciocan, C.V.; Zaharia, G.; Alexe, D.I. Predictors of speed and agility in youth male basketball players. *Appl. Sci.* **2023**, *13*, 7796. [CrossRef]
22. Trecroci, A.; Duca, M.; Formenti, D.; Alberti, G.; Iaia, F.M.; Longo, S. Short-term compound training on physical performance in young soccer players. *Sports* **2020**, *8*, 108. [CrossRef] [PubMed]
23. Lockie, R.G.; Schultz, A.B.; Callaghan, S.J.; Jeffriess, M.D. The effects of traditional and enforced stopping speed and agility training on multidirectional speed and athletic function. *J. Strength Cond. Res.* **2014**, *28*, 1538–1551. [CrossRef] [PubMed]
24. Pojskic, H.; Åslin, E.; Krolo, A.; Jukic, I.; Uljevic, O.; Spasic, M.; Sekulic, D. Importance of reactive agility and change of direction speed in differentiating performance levels in junior soccer players: Reliability and validity of newly developed soccer-specific tests. *Front. Physiol.* **2018**, *9*, 368621. [CrossRef]
25. Stojanovic, E.; Aksovic, N.; Stojiljkovic, N.; Stankovic, R.; Scanlan, A.T.; Milanovic, Z. Reliability, usefulness, and factorial validity of change-of-direction speed tests in adolescent basketball players. *J. Strength Cond. Res.* **2019**, *33*, 3162–3173. [CrossRef]