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VALIDITY, RELIABILITY AND CORRELATES OF FUTSAL-SPECIFIC PRE-PLANNED AND NON-PLANNED AGILITY TESTING PROTOCOLS

VELJAVNOST, ZANESLJIVOST IN KORELATI VNAPREJ NAČRTOVANIH IN NENAČRTOVANIH PROTOKOLOV TESTIRANJA AGILNOSTI, SPECIFIČNIH ZA FUTSAL

ABSTRACT

The importance of agility in futsal is already recognized, but there is an evident lack of information about applicability of futsal specific tests. The aim of this study was to evaluate reliability, validity and correlates of tests evaluating the futsal specific pre-planned agility (PPA), and non-planned agility (NPA).

The sample comprised 40 professional futsal players who were tested on newly developed tests of PPA and NPA, sprint over 10 meters, countermovement jump, body height and mass. The reliability analyses included calculation of intra-session Cronbach Alpha (CA) and Inter-Item-Correlation (IIR), as well as analysis (ANOVA) for repeated measurements. Differences between performance groups (starters [first team] vs. non-starters [substitutes]) were evidenced by t-test for independent samples and calculation of Effect Size differences (ES). Pearson's product moment correlation was calculated to define associations between variables.

The reliability of agility tests was appropriate, with somewhat better reliability of PPA (CA: 0.81 and 0.76, IIR: 0.79 and 0.72, for PPA and NPA, respectively). ANOVA did not reveal any significant differences among testing trials. Starters were had better PPA than non-starters (t-test: 1.98, $p < 0.01$, moderate ES). The PPA and NPA shared less than 40% of the common variance, which suggests that these capacities are independent. Jumping and sprinting were not significantly correlated to PPA and NPA.

Study confirmed appropriate reliability of the newly developed tests, and applicability of the PPA in distinguishing performance-levels. Further studies in females and younger players are warranted.

Key words: reactive agility, change of direction speed, conditioning capacities, open skill agility, closed skill agility

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IZVLEČEK

Agilnost v futsalu vse bolj pridobiva na pomenu, vendar pa je na voljo očitno premalo informacij o uporabnosti testov, specifičnih za futsal. Cilj te raziskave je bil oceniti zanesljivost, veljavnost in korelate testov, ki merijo vnaprej načrtovano agilnost (VNA) in nenačrtovano agilnost (NNA), specifično za futsal.

Vzorec je obsegal 40 profesionalnih igralcev futsala, ki so opravili najnovejše teste VNA in NNA, pretekli 10 metrov sprinta ter izvajali skoke z nasprotnim gibanjem, izmerili pa smo jim tudi telesno višino in maso. Analiza zanesljivosti je vključevala izračun koeficienta Cronbach alfa (CA) med vadbo in korelacijo med postavkami (KMP) ter analizo ANOVA za ponovljene meritve. Razlike med skupinami (začetniki [prva ekipa] proti nezačetnikom [rezerve]) smo ugotavljali s t-testom za neodvisne vzorce in izračunom razlik v velikosti učinka (VU). Izračunali smo Pearsonov koeficient korelacije (produkt-moment), da smo lahko določili povezave med spremenljivkami.

Zanesljivost testov agilnosti je bila ustrezna, z nekoliko boljšo zanesljivostjo VNA (CA: 0,81 in 0,76, KMP: 0,79 in 0,72 za VNA oz. NNA). ANOVA ni pokazala značilnih razlik med testnimi poskusi. Začetniki so imeli boljši VNA kot nezačetniki (t-test: 1,98, $p < 0,01$, zmeren VU). VNA in NNA sta si delila manj kot 40 % skupne variance, kar nakazuje, da so te zmogljivosti neodvisne. Skoki in sprinti niso bili značilno povezani z VNA in NNA.

Raziskava je potrdila ustrezno zanesljivost najnovejših testov ter uporabnost VNA pri razlikovanju ravni uspešnosti. Predvidene so nadaljnje raziskave pri ženskah in mlajših igralcih.

Ključne besede: reactive agility, change of direction speed, conditioning capacities, open skill agility, closed skill agility

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INTRODUCTION

Futsal is a relatively new sport similar to soccer (football) (Farhani et al., 2019). Each team consists of five players in the game, it is played at the smaller indoor court, and the game duration is shorter than in soccer (two times 20 minutes) (Amani-Shalamzari et al., 2019). Since the field is of small dimensions (40 x 20 m), futsal has a higher number of high-intensity activities in comparison with other team sports (Naser, Ali, & Macadam, 2017). Therefore, players must have highly-developed ability of repeated sprinting, leg muscular power and strength, together with ball skills in passing, dribbling and shooting, and well-developed coordination (Serrano, Sánchez-Sánchez, López-Fernández, Hernando, & Gallardo, 2019). However, the most commonly represented activities in the futsal game are acceleration and deceleration with a high number of changes of direction or agility performances (Jiménez-Reyes et al., 2019).

Agility is defined as the ability to efficiently change the speed and direction of movement as a response to stimuli (Sheppard & Young, 2006). Although frequently observed as one capacity (Okur, Taskin, & Taskin, 2019; Şahin et al., 2019), agility has two manifestations (Young, Dawson, & Henry, 2015). The first one is reactive or non-planned agility (NPA), which is characterized with the need of the athlete to detect and to correctly and promptly react to changes of the situations in the game and perform agile manoeuvre (Coh et al, 2018; Sekulic, Krolo, Spasic, Uljevic, & Peric, 2014). The second agility manifestation is called non-reactive or pre-planned agility (PPA) because players know in advance which movement they have to conduct (Sekulic, Uljevic, Peric, Spasic, & Kondric, 2017¸ Young et al., 2015). The PPA is commonly referred as the change of direction speed - CODS) (Sheppard & Young, 2006). With regard to its differentiation, it has to be emphasized that NPA and PPA are two distinct and independent capacities (Young et al., 2015), which is supported by study conducted on youth soccer players that revealed only 25-40 % of the common variance between PPA and NPA (Pojskic et al., 2018).

When we look at the definition of agility and compare it with the demands of futsal, it could be concluded that both types of agility (e.g. NPA and PPA) are the key performance factors for success in the game. Indeed, futsal is an extremely dynamic sport where the ball-manipulations have to be conducted during the agility movements because there is a high number of passes, shots, dribbles, and players have to possess high level of skills associated with ball handling (Naser et al., 2017). Also, it is clear that players at the advanced level must possess highly developed agility capacity because the advancement of the playing level results in advanced game dynamics, frequent occurrence of unpredictable situations in which they have to react appropriately (Oppici, Panchuk, Serpiello, & Farrow, 2018; Taylor, Wright, Dischiavi, Townsend, & Marmon, 2017).

There is a global consensus among sport researchers and practioners that sport-specific tests are more accurate in showing the exact manifestation of the required ability compared to generic tests (Cigrovski, Franjko, Rupčić, Baković, & Matković, 2017; Pehar et al., 2017; Uljevic, Spasic, & Sekulic, 2013). This is the case because sport-specific tests aim to assess the ability in real-life situations and, therefore, are more ecologically valid (Sekulic et al., 2017). Consequently, the importance of sport-specific tests for assessing agility in futsal should be stressed.

Benvenuti et al. (2010) demonstrated that futsal players possess better agility capacity than soccer players. Futsal demands more actions with the ball that include changes of the direction and speed (Ramos-Campo, Rubio-Arias, Carrasco-Poyatos, & Alcaraz, 2016). Thus, it is essential to differently assess athletes of different sports with tests that are constructed with the aim to mimic the real-game situations. In the case of the futsal game, this means constructing the agility test

with ball-manipulations at shorter distances. With this type of tests, futsal-experts would be able to evaluate the level of agility and determine the quality of players. Recently, Sekulic et al. presented a useful testing protocol and evaluated its reliability and validity in Croatian players (Sekulic et al. 2019). However, since reliability is the characteristic of test, but also a characteristic of "sample of participants", additional analyses are needed in order to clearly demonstrate the reliability and usefulness of such tests

The aim of this research was to evaluate the intra-session reliability and applicability of newly-constructed tests of futsal-specific agility with the main hypothesis that tests will differentiate elite futsal players by performance level. Additionally, we evaluated the association between different agility components, sprinting, and jumping capacities in studied players.

METHODS

The sample comprised male futsal players (n = 40; age: 23±2.1 years), separated according to their performance level in two groups: starters (n = 12), and non-starters (n = 28). Coaches determined the quality of players and starters were better players who regularly start the game, while non-starters were regularly their substitutes. All players were members of professional-level teams from Bosnia and Herzegovina and competed at the highest competitive level in the country. They were informed of the implementation and purpose of the testing and gave their informal consent. Study was approved by Ethical Board of University of Split, Faculty of Kinesiology (Ethical Board Approval No: 2181-205-02-05-14-001). Apart from performance level (e.g. starters vs. non-starters), the variables included body mass (BM) and height (BH), sprint 10 meters (SPRINT10M), countermovement jump (CMJ), and newly developed tests of pre-planned agility (PPA) and non-planned agility (NPA).

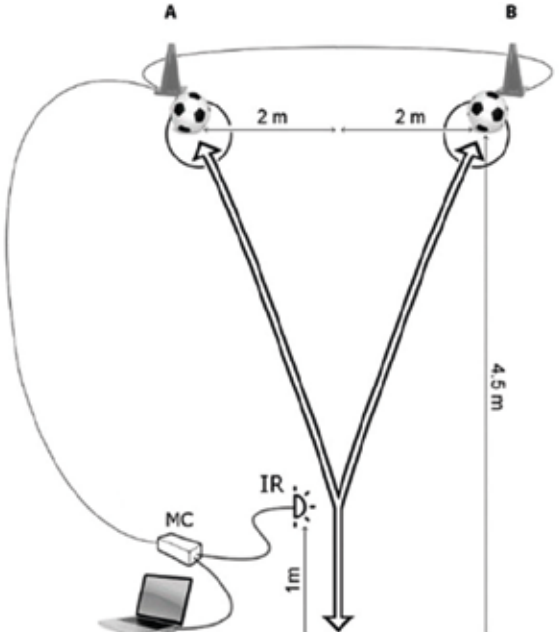
The SPRINT10M was assessed by Powertimer 300 (Newtest, Oulu, Finland) photoelectronic gates. One gate was placed at the start line, and the second 10 meters after the start gate with photocells placed at a 1-meter height. Athletes began test from the standing start one meter before the start line (to avoid accidental arm movements and switching the timing gates). The players were instructed to run from start to finish gate. They performed the test three times, and the best time was used for further analyses. The reliability of the testing was high (Cronbach Alpha: 0.89; Inter-Item-Correlation: 0.81)

The CMJ was measured by Optojump system. The athletes were standing in the middle of two photoelectric beams and were instructed to perform downward movement by bending the hips and knees and to jump upwards maximally. Athletes performed three jumps, and the best (highest) jump was taken into the analysis. The intra-session reliability of the testing was appropriate (Cronbach Alpha: 0.80; Inter-Item-Correlation: 0.76).

This study is a continuation of the recent investigation where authors presented the idea and concept of measurement of futsal specific agility tests and where testing procedures and measurement equipment are presented in detail (Sekulic et al., 2019). In brief, the newly developed PPA and NPA had a "Y" shaped pattern shown in Figure 1. For the NPA, players started running from the start line, 1 m after a start line they crossed the infra-red signal that switched on one of the two lighting cones. Players had to notice which cone was lit, and they had to run in the direction of that cone, touch the ball placed in front of the cone with the sole of the shoe, and run back to the starting gate at maximum speed and the time is recorded. Players had five trials,

and the best result was further analyzed. The PPA test had the same pattern, but the difference was that players knew in advance which cone will light up, so they were able to pre-plan the running direction. Because of its relative simplicity and the fact that players were familiarized with the test in advance, participants executed two trials (one on the left, and one on the right side) and the better time was taken into the analyses. Agility components were measured by newly-constructed equipment described in detail in previous similar studies (Pojskic et al., 2018; Sekulic, Pehar, et al., 2017).

Figure 1. Test of the futsal-specific pre-planned and non-planned agility with ball touching



LEGEND: IR – infrared beam, MC – microcontroller

After checking the normality of distributions by Kolmogorov Smirnov test, the means and standard deviations were calculated as descriptive statistic parameters.

The intra-session reliability of newly developed tests was evidenced by Cronbach Alpha (CA) and average Inter-Item-Correlation (IIR) of the tests.

The presence of systematic bias among testing trials (items) was determined by calculation of analysis of variance (ANOVA).

The associations between variables was evidenced by Pearson's correlations coefficients.

In order to identify the applicability of the tests in differentiating performance levels, t-test for independent samples was calculated between performance-groups. Additionally, differences between performance levels (starters vs. non-starters) were evaluated by the magnitude-based Cohen's effect size (ES) statistic with modified qualitative descriptors (Cohen, 1988). The effect size was assessed using the following criteria: <0.02 = trivial; 0.2–0.6 = small; >0.6–1.2 = moderate; >1.2–2.0 = large; and >2.0 very large differences. Program Statistica v.13.5 (TIBCO Software Inc, Palo Alto, CA) was used for statistical analyses, and p-level of 95% ($p < 0.05$) was applied.

RESULTS

The indicators of reliability of the newly developed tests of futsal specific PPA and NPA are presented in Table 1. Both calculated reliability coefficients reached appropriate numerical values and indicated proper reliability of the agility performances. Also, ANOVA did not reveal any significant differences among testing trails, and therefore no systematic bias was observed. There is a certain trend of improvement in testing results for both PPA and NPA, but this was expected knowing the complexity of the testing procedures.

Table 1. Descriptive statistics and reliability analysis (CA – Cronbach Alpha, IIR – inter-item-correlation, F-test among trials) for futsal specific agility tests

	Mean	Std.Dev.	CA	IIR	F-test
PPA (s)					
Trial 1	2.21	0.19			
Trial 2	2.11	0.20			
PPA final	2.11	0.19	0.81	0.79	1.11
NPA (s)					
Trial 1	2.65	0.31			
Trial 2	2.49	0.28			
Trial 3	2.42	0.29			
Trial 4	2.41	0.36			
Trial 5	2.44	0.50			
NPA final	2.42	0.24	0.76	0.72	2.31

LEGEND: PPA – futsal specific test of pre-planned agility, NPA – futsal specific test of non-planned agility

Performance groups of futsal players differed in body height (starters were taller, t-test: 1.78, $p < 0.05$), and PPA (starters achieved better results than nonstarters, t-test: 1.98. $p < 0.05$) (Table 2).

Table 2. Differences between performance-levels of studied players (starters vs. nonstarters) in studied variables

	Non-starters (n = 28)		Starters (n = 12)		T-test
	Mean	Std.Dev.	Mean	Std.Dev.	t-value (p)
Body height (cm)	181.14	5.21	183.89	6.62	-1.78 (0.03)
Body mass (kg)	79.74	9.31	82.19	13.73	-0.91 (0.18)
CMJ (cm)	38.50	4.98	38.73	5.32	-0.19 (0.43)
SPRINT10M (s)	1.70	0.11	1.72	0.12	-0.46 (0.32)
PPA (s)	2.26	0.21	2.09	0.17	1.98 (0.03)
NPA (s)	2.43	0.25	2.40	0.23	0.51 (0.31)

LEGEND: CMJ – Countermovement jump, SPRINT10M– sprint over 10 meters, PPA – futsal specific test of pre-planned agility, NPA – futsal specific test of non-planned agility

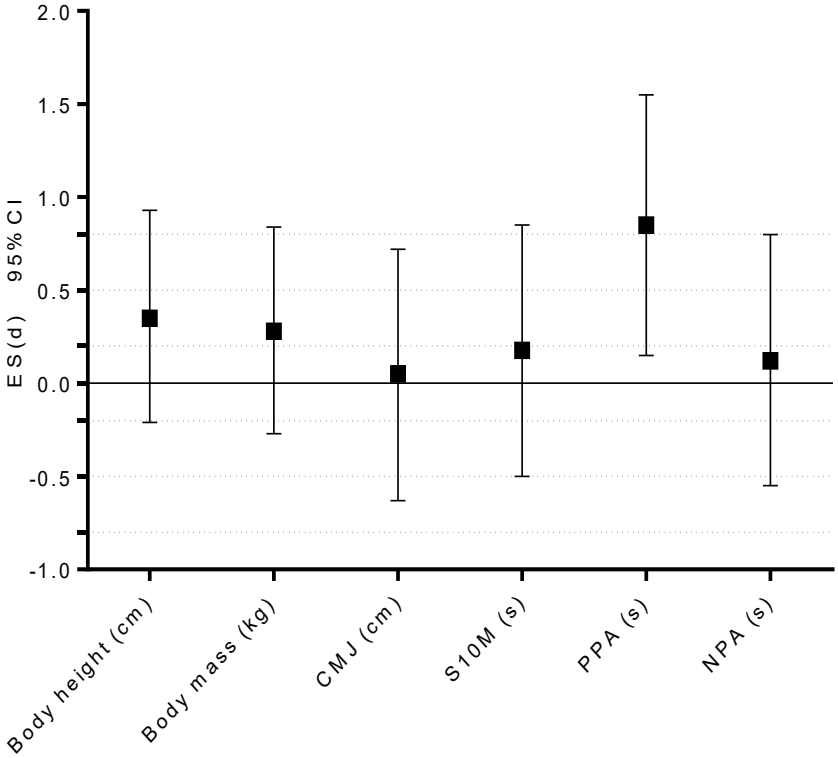
The correlations between studied variables are presented in Table 3. Although the correlation between PPA and NPA was statistically significant, it must be stressed that PPA and NPA share less than 40% of the common variance, and therefore, cannot be considered as single capacity. The correlations between any of the studied capacities (sprinting, jumping), or anthropometric indices (body height and mass) with PPA and NPA did not reach statistical significance.

Table 3. Correlations among studied variables (data are presented Spearman's correlation coefficients (p))

	Body height	Body mass	CMJ	SPRINT10M	PPA
Body mass	0.58 (0.01)				
CMJ	-0.14 (0.47)	-0.26 (0.16)			
SPRINT10M	0.14 (0.47)	0.33 (0.07)	-0.40 (0.03)		
PPA	0.15 (0.47)	0.29 (0.12)	-0.21 (0.27)	0.09 (0.63)	
NPA	0.06 (0.75)	0.27 (0.15)	-0.22 (0.27)	0.12 (0.53)	0.64 (0.01)

LEGEND: CMJ – Countermovement jump, SPRINT10M – sprint over 10 meters, PPA – futsal specific test of pre-planned agility, NPA – futsal specific test of non-planned agility

Figure 2. Effect size differences (± 95% Confidence Interval) between performance levels (starters and non-starters) in studied variables



LEGEND: CMJ – Countermovement jump, SPRINT10M – sprint over 10 meters, PPA – futsal specific test of pre-planned agility, NPA – futsal specific test of non-planned agility; Doted lines present ES ranges (<0.02 = trivial; 0.2–0.6

= small; >0.6–1.2 = moderate; >1.2–2.0 = large; and >2.0 very large differences).
The ES differences between performance groups were moderate for PPA (ES: 0.85, 95%CI: 0.15-1.55), small for body height (ES: 0.35, 95%CI: -0.21-0.93), and body mass (0.28, 95%CI: -0.27-0.84), and trivial for remaining variables (Figure 2).

DISCUSSION

Several main research findings emerged in this study. First, newly developed tests of futsal-specific PPA and NPA are of appropriate reliability. Second, the PPA test was found to be applicable in the differentiation of performance levels of studied players.

Futsal-specific agility tests applied in this study have good reliability (Sekulic et al.,2019), with PPA test being more reliable than NPA, and this is in accordance with recent study where futsal specific tests of PPA and NPA involving dribbling were presented and evaluated (Sekulic et al., 2019). Supportively, similar results are reported in previous studies of sport-specific agility tests in other sports (Pojskic et al., 2018; Sekulic et al., 2017; Spasic, Krolo, Zenic, Delextrat, & Sekulic, 2015). In short, tests of handball-specific PPA had higher reliability than NPA tests when testing adult male and female handball players (ICC=0.91 and 0.85 for PPA and NPA, respectively) (Spasic et al., 2015). Similar results were evidenced in the study with top-level basketball players, where ICC values of NPA and PPA were 0.85 and 0.95, respectively (Sekulic et al., 2017). Furthermore, Pojskic et al. (2018) have evaluated the reliability of soccer-specific agility tests conducted on youth soccer players and reported good reliability with PPA being more reliable than NPA test.

The main explanation of previously displayed results showing better reliability of PPA is related to the fact that NPA is generally more complex ability than PPA. Briefly, while PPA determinants are conditioning capacities, such as speed, leg muscle strength, power and reactive strength (Paul, Gabbett, & Nassis, 2016), the NPA additionally challenges numerous cognitive and perceptual capacities (Young et al., 2015). Having in mind that increased complexity of the required task leads to greater possibility of non-systematic error in testing, it is logical that the reliability of the test will be altered with its complexity (Sekulic et al., 2017). Cognitive and perceptual abilities are very sensitive and have large variability and inconsistency (Schapschröer, Lemez, Baker, & Schorer, 2016), so it is logical to expect that performances which depend on those capacities (i.e., NPA) will be less reliable in comparison to tests where perceptual and cognitive capacities are not challenged (i.e., PPA). However, both newly developed and here examined tests displayed appropriate reliability and thus could be used for assessing agility at futsal players.

The PPA test is shown to be valid at differentiating the players according to their performance level, and starters outperformed non-starters in PPA test. There are two possible explanations for these results. First, starters are more involved in the game and have increased physical load. As a result, it could directly influence the development of their fitness capacities including PPA in real-game settings. Secondly, it is possible that players with superior PPA are simply recognized as being better players and, therefore, are more involved in game, as starters. However, for a precise evaluation of the problem, further studies are needed.

Different agility components are already recognized as being important determinants of success in various team sports (sport games) (Paul, Gabbett, & Nassis, 2016). For the example, basketball-specific agility tests have been shown to be applicable for differentiating the competitive levels of elite basketball players in first-division and second-division players (Sekulic et al., 2017).

However, in that study the basketball specific NPA differentiated the players better than PPA (Sekulic et al., 2017). In the study with youth football players, Pojskic et al. (2018) displayed that tests of NPA and PPA could be used for categorizing performance levels of youth soccer players, contrary to several tests of generic capacities that did not differentiate performance-levels. The authors of that study explained that better players have more developed cognitive capacities and technical skills crucial for sport-specific agility, while because of its advanced level, all studied players had similarly developed basic conditioning capacities. In that investigation, the PPA explained the differences between performance levels better than NPA (Pojskic et al., 2018).

Indeed, even in this study observed futsal players were adult players with long experience in futsal training and competition. Consequently, they possess a high level of conditioning capacities, technical skills, and the perceptual-cognitive capacities necessary to detect and to adjust to the newly-emerged situations in the game. Performance groups (e.g. starters and non-starters) differentiated only in PPA test probably because starters are simply more involved in the futsal match and spend more time essential for the development of conditioning capacities. However, PPA test can be used for differentiating players according to performance levels; thus, the second hypothesis of this research is partially confirmed.

Limitations and strengths

This study has several limitations. First, the investigation involved only male players of senior level, and results are therefore applicable and generalizable to similar samples. Knowing that reliability of the tests is both characteristic of (i) measurement protocol, and (ii) sample of subjects, the reliability of the tests in other samples should be evaluated. Also, this study observed only several additional conditioning capacities, and it is important to expand the investigation and to observe large set of variables simultaneously. Moreover, this is a cross-sectional study which means that it shows only associations among studied variables and does not show causality. On the other hand, it must be mentioned that this is one of the first studies where exclusively top-level players were investigated. Therefore, the results presented may be observed as valuable contribution to this sport.

CONCLUSION

The results of the study displayed that specifically-developed futsal agility tests that include simple futsal specific ball-manipulating skills are reliable tests for male futsal players. Since this study included a relatively large number of elite futsal players, the results could be used as normative values for training and conditioning in this sport.

As PPA test was found to be applicable for differentiating starters and non-starters, this test could be used in order to distinguish the performance levels in futsal. Meanwhile, it is possible that complexity of the NPA was too pronounced, which limited its discriminative validity in studied futsal players. Therefore, it is probable that NPA tests presented in this study should be simplified, in order to increase its discriminative validity.

This research has supported the importance of testing PPA and NPA separately as those abilities are independent and should be observed as separated capacities in futsal.

In future studies the here proposed tests should be evaluated with younger male players and among female futsal players Also, there is a limited body of knowledge about the effectiveness of different training modalities on agility. Therefore, the studies which will evaluate the effectiveness of training programs will certainly be of interest for sport -practioners since it will allow them to address the most appropriate and effective modalities for developing the futsal-specific abilities crucial for the successful match performance.

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