

# PREDICTING FUTSAL SPECIFIC CHANGE OF DIRECTION SPEED AND REACTIVE AGILITY; ANALYSIS OF SPECIFIC CORRELATES IN TOP-LEVEL PLAYERS

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## ABSTRACT

**Purpose:** Change of direction speed (CODS) and reactive agility (RAG) are important qualities in futsal, but studies rarely examined the predictors of these conditioning capacities in players of advanced level. This study aimed to evaluate predictive validity of certain anthropometric and conditioning capacities in evaluation of futsal specific CODS and RAG in top-level players.

**Methods:** The sample comprised 54 male players from Croatia and Bosnia and Herzegovina, members of teams competing at the highest national rank, including national champions for the 2017–2018 competitive season in both countries. The variables comprised set of predictors (body mass, body height, triceps skinfold, reactive strength index [RSI], sprint 10 m [S10M], and broad jump [BJ]); and four criteria: futsal specific CODS and RAG, performed with and without dribbling (CODS\_D, CODS\_WD, RAG\_D, RAG\_WD). To identify the association between variables Pearson's correlation and multiple regressions were calculated.

**Results:** Observed predictors explained statistically significant ( $p < 0.05$ ) percentage of variance for all four criteria (Rs<sub>q</sub>: 0.28, 0.30, 0.23 and 0.25, for CODS\_WD, CODS\_D, RAG\_WD, RAG\_D, respectively). Body mass was significant predictor for all criteria (Beta: 0.35–0.51), with poorer performances in heavier players. In both performances which involved dribbling, significant predictors was RSI (Beta: –0.27 and –0.31 for CODS\_D and RAG\_D, respectively), with superior performances in players with better RSI. The S10M and BJ were not identified as being significantly correlated to studied RAG and CODS performances.

**Conclusion:** Study confirmed specific influence of studied predictors of futsal specific CODS and RAG with consistent negative influence of body mass on studied performances. Almost certainly this can be explained by specifics of RAG and CODS execution. Specifically, tests are performed over relatively small distances, with several changes of direction, which clearly mimic the futsal specific performances. Although sprint performance is often observed as important determinant of CODS and RAG, herein we did not confirm its predictive validity in explanation of futsal specific CODS and RAG. Future studies should evaluate other potentially important predictors of these capacities in futsal.

**Keywords:** prediction; multiple regression; conditioning capacities; pre-planned agility; non-planned agility

## Introduction

Agility can be defined as the ability to rapidly change direction and speed of movement. It is a highly complex quality, and differentiation between non-reactive agility (i.e. change of direction speed – CODS), and reactive agility (RAG) deserves special attention. In brief, while CODS involves an active change of direction speed, RAG is performed throughout a non-planned scenario to which the athlete must respond to a specific visual or audio stimulus by performing a precise change of direction as quickly as possible (Pojskic et al., 2018). Research has shown that CODS and RAG are independent qualities. Specifically, the percentage of common variance of these two qualities rarely exceeded 30% which indicate that RAG and CODS should be tested and trained separately (Serpell et al., 2010).

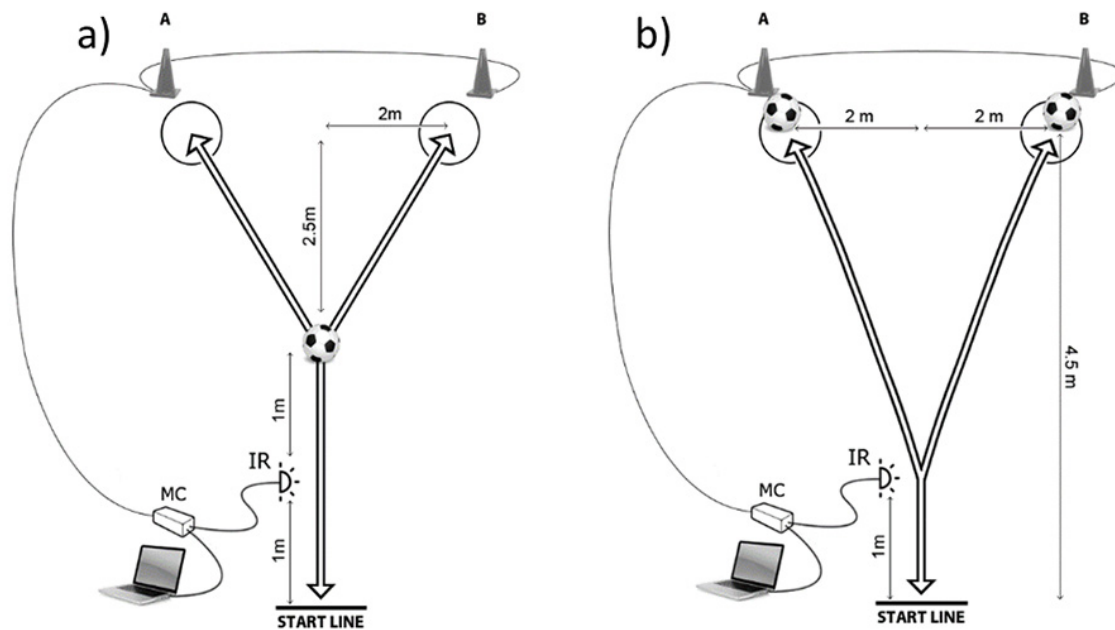
Due to the diversity of agility maneuvers within a sport and between sports, agility components are hard to develop in general (i.e. each type of agility requires specific exercises). Therefore, knowing which factors directly influence agility could lead to specific training and the development of these factors to improve different types of agility performances. However, most of the studies done so far examined the factors associated with CODS, while there is a limited number of studies where authors reported factors associated with RAG (Pehar et al., 2018; Sekulic et al., 2013). What is also important, recent analyses confirmed the necessity of investigation of sport-specific testing protocols in order to precisely accentuate the type of CODS and RAG which appears in sport of interest (Pehar et al., 2018, Spasic et al., 2015).

Futsal is a sport that involves intermittent periods of high-intensity physical effort over two, 20-minute periods per game, and research shows that agility appears to be a vital component to successful play since sport requires sudden changes in movement patterns, fast sprints, and rapid decision-making to obtain or maintain ball possession (Teixeira et al., 2019). However, studies which specifically examined agility in futsal are limited, while to the best of our knowledge no study so far directly reported factors associated to CODS and RAG in this sport. Therefore, the aim of this study was to evaluate predictive validity of certain anthropometric and conditioning capacities in evaluation of futsal specific CODS and RAG in top-level futsal players.

## Methods

The sample participants in this study comprised 54 male futsal players from Croatia and Bosnia and Herzegovina (age:  $25 \pm 4.1$  years, body height:  $182 \pm 5-8$  cm, mass:  $81 \pm 12.3$  kg), members of teams competing at the highest national rank, including national champions for the 2017–2018 competitive season in both countries. The participants were selected based on the following criteria: older than 18 years of age; free from injury or illness; and have regularly performed standard training for at least three weeks prior the study. Goalkeepers were not included in this investigation.

The variables comprised set of predictors (body mass, body height, triceps skinfold, reactive strength index [RSI], sprint 10 m [S10M], and broad jump [BJ]); and four criteria: futsal specific CODS and RAG, performed with and without dribbling (CODS\_D, CODS\_WD, RAG\_D, RAG\_WD). Body mass, body height, and triceps skinfold were measured by standard techniques and calibrated equipment. The BJ (in cm) was measured using the standardized measuring mat (Elan, Begunje, Slovenia) throughout three attempts and the best performance was used as the final result for each player. The S10M (in 0.01 s) was evaluated by Muscle Lab timing gate (Muscle Lab, Norway), participants performed three sprints with 2–3 minutes rest, and the best achievement was used as final result for each player. The RSI (index) was derived from the height jumped in a 30-cm depth jump, and the time spent on the ground developing the forces required for that jump, which was measured by Optojump system (Microgate, Bolzano, Italy). The RAG and CODS performances were measured by futsal specific protocols involving test executions with dribbling (CODS\_D, and RAG\_D), and without dribbling the ball (CODS\_WD, and RAG\_WD) (Figure 1). In general, RAG tests were commenced throughout five-, and CODS tests throughout three-testing-trials, and the best result of each participant for each test was used for statistical analyses (in 0.01 s).



**Figure 1** Testing of the futsal specific change of direction speed and reactive agility (a) with dribbling, and (b) without dribbling

Statistics included means and standard deviations, while the associations between predictors and agility performances were evaluated by Pearson's correlation coefficients, and multiple regression calculations. The alpha level of  $< 0.05$  was applied.

## Results

Descriptive statistics for obtained variables are presented in Table 1. The CODS performances are approximately 15% faster than corresponding RAG performances. Also, the performances with ball are 13–15% slower than corresponding performances that didn't include dribbling.

**Table 1** Descriptive statistics for obtained variables

	Mean	Minimum	Maximum	Std.Dev.
<b>BH (cm)</b>	182.66	168.00	197.50	5.86
<b>BM (kg)</b>	80.92	56.50	139.90	12.27
<b>TrSF (mm)</b>	10.71	3.90	25.20	4.60
<b>BJ (cm)</b>	238.45	195.00	279.00	19.74
<b>RSI (index)</b>	148.48	62.24	222.30	36.67
<b>CODS_WD (s)</b>	2.16	1.83	2.75	0.20
<b>CODS_D (s)</b>	2.54	2.04	3.24	0.26
<b>RAG_WD (s)</b>	2.47	2.12	3.18	0.26
<b>RAG_D (s)</b>	2.68	2.20	3.51	0.26

**LEGEND:** BH – body height, BM – body mass, TrSF – triceps skinfold, BJ – broad jump. RSI – reactive strength index. CODS\_WD – change of direction speed performed without dribbling the ball, CODS\_D – change of direction speed performed with dribbling the ball, RAG\_WD – reactive agility performed without dribbling, RAG\_D – reactive agility performed with dribbling

Pearson's correlation coefficients indicate significant correlation between body mass and RSI with all observed agility performances. Similarly, triceps skinfold and BJ were significantly correlated with three of four agility performances (Table 2).

**Table 2** Pearson's correlation coefficients between observed variables (\* denotes statistical significance of  $p < 0.05$ )

	CODS_WD (s)	CODS_D (s)	RAG_D (s)	RAG_WD (s)
<b>BH (cm)</b>	0.17	0.18	0.05	0.04
<b>BM (kg)</b>	0.41*	0.46*	0.34*	0.32*
<b>TrSF (mm)</b>	0.36*	0.33*	0.28*	0.22
<b>BJ (cm)</b>	-0.29*	-0.30*	-0.30*	-0.19
<b>RSI (index)</b>	-0.40*	-0.34*	-0.33*	-0.35*

**LEGEND:** BH – body height, BM – body mass, TrSF – triceps skinfold, BJ – broad jump. RSI – reactive strength index. CODS\_WD – change of direction speed performed without dribbling the ball, CODS\_D – change of direction speed performed with dribbling the ball, RAG\_WD – reactive agility performed without dribbling, RAG\_D – reactive agility performed with dribbling

**Table 3** Multiple regression results between predictors and agility-performances criteria (\* denotes statistical significance of  $p < 0.05$ )

	Criteria			
	CODS_WD (s)	CODS_D (s)	RAG_D (s)	RAG_WD (s)
<b>Predictors</b>	Beta	Beta	Beta	Beta
<b>BH (cm)</b>	0.10	0.09	0.11	0.04
<b>BM (kg)</b>	0.49*	0.51*	0.35*	0.37*
<b>TrSF (mm)</b>	0.20	0.18	0.14	0.10
<b>BJ (cm)</b>	-0.11	-0.09	-0.12	-0.04
<b>RSI (index)</b>	-0.12	-0.27*	-0.11	-0.31*
<b>R</b>	0.52*	0.55*	0.48*	0.51*
<b>Rsqr</b>	0.28*	0.30*	0.23*	0.25*

**LEGEND:** BH – body height, BM – body mass, TrSF – triceps skinfold, BJ – broad jump. RSI – reactive strength index. CODS\_WD – change of direction speed performed without dribbling the ball, CODS\_D – change of direction speed performed with dribbling the ball, RAG\_WD – reactive agility performed without dribbling, RAG\_D – reactive agility performed with dribbling; Beta – standardized regression coefficient, R – multiple correlation coefficient, Rsqr – coefficient of determination

Observed predictors explained statistically significant ( $p < 0.05$ ) percentage of variance for all four criteria (Rsqr: 0.28, 0.30, 0.23 and 0.25, for CODS\_WD, CODS\_D, RAG\_WD, RAG\_D, respectively). Body mass was significant predictor for all criteria (Beta: 0.35–0.51), with poorer performances in heavier players. In both performances which involved dribbling, significant predictors was RSI (Beta: -0.27 and -0.31 for CODS\_D and RAG\_D, respectively), with superior performances in players with better RSI.

## Discussion

Body mass was found significantly partially related to all CODS and RAG performances, with poorer performance in heavier players. The mechanism of (negative) influence of body mass on agility

performances is relatively understandable, knowing the characteristic of the test performance. In brief, the RAG and CODS tests used in this study involve several changes of direction, including pre-planned and non-planned scenarios (for CODS and RAG, respectively). While all changes of direction are performed after achieving highest possible velocities over distance of approximately 3 meters (see Figure 1 for details) it is understandable that higher body mass will negatively influence the capability to effectively perform necessary change of direction, irrespective of its non-planned, or pre-planned nature. Supportively, previous studies where authors investigated the predictors of various agility performances noted similar associations between body mass and agility in basketball players (Pehar et al., 2018).

A certain novelty of our study is the fact that this is probably the first study which confirmed negative influence of higher body mass on agility performances which include dribbling with the ball. However, it is clear that association between body mass and performances which include dribbling (CODS\_D, RAG\_D) are less pronounced than associations between body mass and less complex agility performance (e.g. those which doesn't involve dribbling the ball; CODS\_WD, and RAG\_WD). This finding is almost certainly related to the overall influence of skill-level on studied agility performances. In brief, the level of characteristic futsal skill greatly influences the level of performances which involve dribbling, irrespective of other characteristics (i.e. anthropometrics) and capacities (i.e. power, sprinting). Consequently, somewhat lower correlation between body mass with performances which involve dribbling (RAG\_D and CODS\_D) is understandable.

Previous studies which investigated the predictors of different agility performances already highlighted the theoretical importance of different forms of RSI in explaining the variance of CODS and RAG. Specifically, Pehar et al. in recent study noted the importance of this quality in explaining basketball specific CODS and RAG, while Young et al. noted superior agility in Australian-rules football players who had better RSI (Pehar et al., 2018; Young et al., 2015). This association is explainable knowing the physiological basis of RSI, and similarity of this muscular capacity with agility performances. In short, RSI is the ability to efficiently switch between eccentric and concentric muscular contractions, or in other words – the ability to efficiently perform plyometric activities). Physiologically, the stretch shortening cycle results in more powerful contractions than purely concentric action (Flanagan & Comyns, 2008) The stretch shortening cycle that occurs in the eccentric part of plyometric performance increases the excitability of proprioceptors (mostly the Golgi tendon organ and muscle spindle) and results in an optimal reaction of the neuromuscular system, which naturally contributes to better agility performance as well (Sattler et al., 2015).

Although previous studies regularly noted the importance of sprinting and horizontal jumping on CODS and RAG performance (Sekulic et al., 2013), in our study neither S10M, nor BJ were found as significantly related to futsal specific CODS and RAG. Two explanations are plausible in defining the differences in findings between our results and those obtained previously. First, RAG and CODS tests in this study involved performances over relatively short distance, and several changes of directions (see Figure 1 for test dimensions). Therefore, although horizontal displacement capacity (i.e. sprint, horizontal jump) may theoretically be beneficial in RAG and CODS, the test dimensions actually decreased the influence of both S10M and BJ on studied agility-performances. Second, all variations of the RAG and CODS tests observed here were relatively complex. Consequently, the influence of “energetic capacities” (i.e. power, sprint) is logically lower than influence of some qualitative physical capacities (i.e. coordination).

## **Conclusion**

The study highlighted importance of players' body mass and RSI on RAG and CODS performances. In general, the most superior RAG and CODS performances are expected of those players who have relatively low body mass and good RSI. However, while body mass was found as significant predictor of all studied performances, the RSI significantly influenced RAG and CODS which involved dribbling with the ball. These information should be disseminated to strength and conditioning coaches working with futsal players. This is particularly important knowing that sprinting and horizontal jumping (i.e. power-related capacities) were not evidenced as significant predictors of studied futsal specific RAG and CODS, while most of the strength and conditioning programs actually aim toward development of these capacities as a way of improvement of various agility performances.

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