

AESA Conference- Special Issue**Reliability of the newly developed tests of handball specific change of direction speed and reactive agility****Vladimir Pokrajčić¹, Dora Marić^{2,3}, Nikola Foretić³, Ognjen Uljević³**

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ABSTRACT

Agility is an important factor of success in handball. There is a lack of reliable specific tests for the evaluation of different agility components in handball. In this study, we evaluated the reliability of the two newly developed tests of agility for handball. The sample consisted of 6 senior male amateur handball players (age: 19,83 years) who were tested on anthropometrics (body height: 185,5 cm, body mass: 84 kg), newly developed tests of handball specific reactive agility (HS-RAGL), and change of direction speed (HS-CODSL). The relative reliability is evaluated by calculation of Intra-Class-Correlation coefficients (ICC), while the absolute reliability was evaluated by calculation of the coefficient of variation (CV). Further, systematic bias was checked by analysis of variance for repeated measurements (ANOVA). The associations between studied variables were evidenced by Pearson's correlation. The reliability statistic for HS-CODSL L and HS-RAGL L are shown in table 1. CA ranges from 0.92 to 0.95, IIR is 0.88, and CV ranges from 7.27% to 8.24%, while in HS-CODSL and HS-RAGL CA ranges from 0.91 to 0.93, IIR ranges from 0.78 to 0.80, and CV ranges from 7.98% to 8.75%. Correlation analysis of the HS-CODSL test performance on the left and right side (three trials), identified a statistically significant correlation between; (i) HS-CODSL D1 and HS-CODSL L2 ($R=0.97$, $p<0.05$) (ii) HS-CODSL D1 and HS-CODSL D2 ($R=0.84$, $p<0.05$), (iii) HS-CODSL D1 and HS-CODSL L3 ($R=0.94$, $p<0.05$), (iv) HS-CODSL D1 and HS-CODSL D3 ($R=0.85$, $p<0.05$), (v) HS-CODSL L2 and HS-CODSL L3 ($R=0.98$, $p<0.05$), (vi) HS-CODSL L2 and HS-CODSL D3 ($R=0.83$, $p<0.05$). While the correlation analysis of the HS-RAGL test performance on the left and right side (three trials), identified a statistically significant correlation between almost all test performances, and the most significant correlation coefficient was found between; (i) HS-RAGL L1 and HS-RAGL D1 ($R=0.97$, $p<0.05$) (ii) HS-

RAGL L1 and HS-RAGL D2 ($R=0.96$, $p<0.05$), (iii) HS-RAGL D1 and HS-RAGL L2 ($R=0.95$, $p<0.05$). Results showed appropriate reliability of the newly developed tests of handball specific change of direction speed and reactive agility. Therefore, here proposed H-CODS and H-RAG can be used as reliable measures of agility components in handball. Further studies should evaluate the discriminative validity of the here proposed tests (i.e. identification of position-specific or performance-related differences), as well as reliability in different handball categories than those studied herein.

KEYWORDS: team handball, pre-planned agility, assessment, sport-specific test

INTRODUCTION

Handball is a fast and explosive team sport game in which two teams collide on a 40 x 20-m court. Matches are divided into two halves of 30 min each, with half-time that cannot exceed 15 minutes. Player's activities are characterised by repeated jumps, sprints, body contact at high speed, specific technical movement patterns, and changes in direction, occurring in response to the varying tactical situations of the game (1). Changes of directions are present in all phases of the handball game; positional and transitional attack and defence. They are also part of many individual attacking technical elements, such as feinting with the ball or feinting without the ball. Individual defence technique is also unthinkable without changes of direction. Elements in which this is evident are: lateral movements in shallow defences, moving back and forth in deep defences, man to man defending or ball stealing. All those elements need to be executed as fast as possible without losing body balance or movement control. In other words, they need to be done agile. Obviously, top performance handball players, on all playing positions, must have well developed agility capacities (2).

Agility is a motor ability that directly influences successful performance in a majority of team sports (3).

Traditionally it was defined as a performance quality of an athlete to rapidly change direction and speed of movement (4). More recently, agility is considered as a rapid whole-body movement with a change of velocity or direction in response to a stimulus (5). Agility has two main components: change of direction speed component and perceptual and decision-making component (5, 6).

In handball, agility appears in two forms dependable on game situations; non-reactive (H-CODS) – pre-planned players' change of direction that is not conditioned by any external factor and reactive (H-RAG) – non-planned change of direction that is influenced by opponent action. Both forms appear with or without the ball and are of huge importance for effective playing performance in handball.

As one of the most important motor abilities in handball, agility should be regularly monitored. Testing results would be more relevant if a player could be tested in sport-specific conditions. Particularly, in situations that are simulating agile movements that usually occur during the game. Specific tests that are constructed in this way better assess players capacities for successful performance than generic fitness tests (7). Along with simplicity and efficiency sport-specific tests must have acceptable metric characteristics. Above all tests must have satisfying reliability.

Literature review indicates a lack of reliable sport-specific agility tests in handball, specifically those that assess

reactive agility component. Correspondingly, the main goal of this study was construction and evaluation of reliability of two newly developed tests. Authors are of the opinion that these tests assess specific change of direction speed and reactive agility in handball.

METHODS

Subjects

Subjects in this study were 6 senior male amateur handball players (age: 19,83 years, body height: 185,5 cm, body mass: 84 kg). The ethics board of the author's institution provided approval of the research experiment. Participants voluntarily took part in the testing after they provided written consent. All players had been playing handball for at least 10 years. The average training frequency of all players ranged from 10 to 14 hours per week, with an average of 4-5 sessions weekly.

Procedures

Players were tested on 2 basic anthropometric variables; body height (BH) and body mass (BM). Body height was measured with GPM anthropometer (*Siber Hegner*, Zurich, Switzerland) while body mass was assessed using the *Tanita BC-418* device (Amsterdam, Netherlands). The agility variables included 2 newly developed tests of handball specific reactive agility (HS-RAGL) and change of direction speed (HS-CODSL).

The specific handball agility was tested with one protocol that evaluated the HS-CODSL and one protocol for the HS-RAGL, and the testing was performed on wooden sports floor. All performances were tested with the same equipment and test set-up, with the difference that the participants in the HS-CODSL protocol were aware of the movement pattern in advance. In contrast, the participants had no advanced knowledge of the testing scenario

when they performed the HS-RAGL testing protocols. Each protocol consisted of 5 trials.

Measurements were performed using a hardware device system based on an ATMEL micro-controller (model AT89C51RE2; ATMEL Corp, San Jose, CA, United States) as the core of the system. A photoelectric infrared (IR) sensor (E18-D80NK) was used as an external time triggering input, and LEDs were used as controlled outputs. The photoelectric IR sensor has been shown to be as reliable as high-speed sensors, with a response time of less than 2 ms (500 Hz) and a digital output signal. The sensor's detection distance ranged from 3 to 80 cm and was capable of detecting transparent or opaque objects. Because it has a digital output (high-low state) with an NPN transistor open collector, the sensor is connected through a microcontroller IO port. For the purposes of our study, this device was connected to a laptop PC operated on Windows 7. This equipment has previously been used and proven to be both valid and reliable for reactive agility and CODS assessments in football (8, 9).

The HS-CODSL and HS-RAGL were performed in the testing area shown in Figure 1. The participants commenced from the start line, and the timing was initiated when they crossed the IR signal. At this particular moment, a hardware module (microcontroller – MC) lit one of the two LEDs placed inside the 30-cm-high cones (labelled A and B). When tested on the HS-RAGL, the participant had to assess which cone was lit, run to the particular cone, collect the ball placed in front of the cone, shoot at the handball goal (20 meters distance), and return to the start line as quickly as possible. Participant had to score in a way that the ball doesn't touch the floor before goalkeepers' area (6 meters line). When a participant crossed the IR signal on their way back, the timing stopped. Testing of the HS-RAGL was performed over three protocols and the participants had no

advanced knowledge of the testing scenario. The participants performed the protocols in random order. Following the reliability analysis (refer to the results on reliability), the best achievement for each of the three protocols was employed as the final result for each participant. The rest period between attempts was 10–15 s with 3 min of recovery between the protocols. The testing of the HS-CODSL was similar to the testing of the HS-RAGL performances; however, a participant had advanced knowledge of which cone would light up and only one protocol that consisted of five attempts was performed (scenario: A-B-A-B-A). Following the reliability analysis, the best achievement was retained as the final result for each participant.

Statistical analysis

Statistical analysis included the calculation of descriptive statistical parameters (arithmetic means and standard deviations) and reliability parameters for test and retest performance. For this purpose, the Intra-Class-Correlation coefficient (ICC), the Cronbach Alpha (CA), the coefficient of variation (CV) parameters were calculated. The association between the variables was determined by Pearson's correlation analysis. Statistica program ver. 13.5 (Tibco Inc., Palo Alto, CA, USA) was used for all calculations, with the significance level of $p < 0.05$ applied for all calculations.

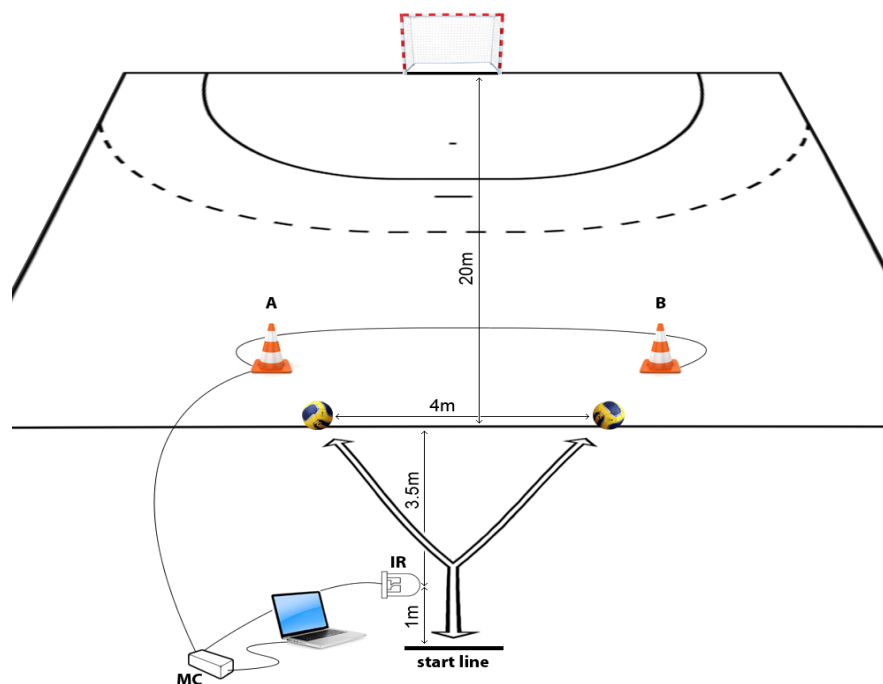


Figure 1. Tests of specific handball agility (HS-CODSL and HS-RAGL)

STATISTICAL RESULTS

The reliability statistic results for H-CODL and HS-RAGL tests are shown in table 1. CA for the left side of performance ranges from 0.92 to 0.95, IIR is 0.88, and CV ranges from 7.27% to 8.24%. On the other hand, in H-CODL and HS-RAGL CA ranges from 0.91 to 0.93, IIR ranges from 0.78 to 0.80, and CV ranges from 7.98% to 8.75%.

Table 1. Descriptive statistics and reliability parameters for newly constructed HS-RAGL and HS-CODSL tests for handball

	Mean	SD	Min	Max	CV	CA	ICC
HS-CODSL L	3.15	0.19	2.85	3.34	7.27%	0.92	0.88
HS-CODSL D	3.47	0.19	3.19	3.76	7.98%	0.93	0.8
HS-RAGL D	3.48	0.27	3.07	3.86	8.75%	0.91	0.78
HS-RAGL L	3.62	0.26	3.31	4.04	8.24%	0.95	0.88

LEGEND: HS-CODSL – handball specific non-reactive agility test, / L - indicates tests performed on the left side, / D - indicates tests performed on the right side, HS-RAGL- handball specific test of reactive agility, / L - indicates tests performed on the left side, / D - indicates tests that are performed to the right, Mean; SD - standard deviation; CV - coefficient of variation; CA - Cronbach Alpha; IIR – inter-item correlation, Min – minimum value/result, Max – maximum value/result

Table 2 show correlation (Pearson's correlation coefficient) of HS-CODSL test regarding left and right side of performance. Correlation analysis of the HS-CODSL test performance on the left and right side (three trials), identified a statistically significant correlation between; (i) HS-CODSL D1 and HS-CODSL L2 ($R=0.97$, $p<0.05$) (ii) HS-CODSL D1 and HS-CODSL D2 ($R=0.84$, $p<0.05$), (iii) HS-CODSL D1 and HS-CODSL L3 ($R=0.94$, $p<0.05$), (iv) HS-CODSL D1 and HS-CODSL D3 ($R=0.85$, $p<0.05$), (v) HS-CODSL L2 and HS-CODSL L3 ($R=0.98$, $p<0.05$), (vi) HS-CODSL L2 and HS-CODSL D3 ($R=0.83$, $p<0.05$).

Table 2. Correlation (Pearson's correlation coefficient) of HS-CODSL test left and right-side performance, three trials

	HS-CODSL L1	HS-CODSL D1	HS-CODSL L2	HS-CODSL D2	HS-CODSL L3
HS-CODSL D1	0.64				
HS-CODSL L2	0.68	0.97*			
HS-CODSL D2	0.62	0.84*	0.73		
HS-CODSL L3	0.73	0.94*	0.98*	0.74	
HS-CODSL D3	0.37	0.85*	0.83*	0.65	0.77

LEGEND: HS-CODSL – handball specific non-reactive agility test, / L - indicates tests performed on the left side, / D - indicates tests performed on the right side

Table 3 show the correlation (Pearson's correlation coefficient) of the HS-RAGL test regarding the left and right side of performance. Correlation analysis of the HS-RAGL test performance on the left and right side (three trials), identified a statistically significant correlation between almost all test performances, and the most significant correlation coefficient was found between; (i) HS-RAGL L1 and HS-RAGL D1 ($R=0.97$, $p<0.05$) (ii) HS-RAGL L1 and HS-RAGL D2 ($R=0.96$, $p<0.05$), (iii) HS-RAGL D1 and HS-RAGL L2 ($R=0.95$, $p<0.05$).

	HS-RAGL L1	HS-RAGL D1	HS-RAGL L2	HS-RAGL D2	HS-RAGL L3
HS-RAGL D1	0.97*				
HS-RAGL L2	0.89*	0.95*			

HS-RAGL D2	0.96*	0.88*	0.79		
HS-RAGL L3	0.93*	0.86*	0.79	0.99*	
HS-RAGL D3	0.70	0.72	0.85*	0.69	0.73

Table 3. Correlation (Pearson's correlation coefficient) of RAGL test left and right-side performance, three trials

LEGEND: HS-RAGL- handball specific test of reactive agility, / L - indicates tests performed on the left side, / D - indicates tests that are performed to the right

DISCUSSION

Results of the study indicate two important findings: (i) newly designed handball specific reactive and non-reactive agility tests have high reliability and (ii) handball specific reactive and non-reactive tests showed inconsistent results dependable on the side of performance.

The newly constructed reactive and non-reactive sport-specific handball agility tests have high reliability, both on the left and on the right side with minimal differences. Alike results were reported in studies that used same technology and similar tests but in different sports. High reliability of reactive agility was also noticed in football, basketball, and futsal (8, 10-13).

The reliability results can be attributed to the relatively short duration of the tests and the relatively simple performance. Specifically, although we are unable to find exact scientific evidence, the authors have experience in coaching handball and know the value empirically we can argue with great certainty that handball players, when tested in an environment with the teammates, are very competitive (14). Given that this type of test was performed for the first time, and test is quickly derived, it is assumed that it had a positive psychological impact on the respondents and they were strongly motivated to give their maximum during testing.

Furthermore, tests were designed to simulate situations in handball attack transition that is becoming more common last few years. Namely, new handball rule which allows attack play without

goalkeeper generates every match several situations in which any defender must come in the fast ball possession with the opportunity to score on the empty goal from far distance - 20 and more meters (15). Some teams are pushing players to execute fast throw-off from which player can shoot to the empty goal. More chance for scoring player has if the ball is shoot directly, without touching the ground. Mentioned situations demand from players agile movement and fast situation recognition. All these elements are present in tests used in our study and most probably additionally enhanced players' motivation to execute them properly and contributing to the high reliability of tests themselves.

Among other things, it is important to point out that although both tests show high reliability, inconsistencies were observed between the tests. Especially, the subjects achieved better test times when performing tests on the left side in the case of the HS-CODSL test, which was not the case with the HS-RAGL test. It is assumed that the cause of this phenomenon is an unequal number of repetitions to the right (3 times) and left (2 times) side in the HS-RAGL test. Mean results to the right and separately to the left was taken as the final result. Therefore, an incorrect reaction in the case of left side performance had a more significant impact on the result than when an error occurred on the right where they have a higher number of attempts. Similar findings were noticed in the study of Telenta et al. (2020) conducted on elementary school children (16). To avoid such mistakes in the future, the author's advice is to run the test through an equal number of repetitions to the right and left side. It is also important not to share this information with the respondents, so knowing of direction couldn't enable them

to anticipate which side the last cone will be lit.

CONCLUSION

The handball-specific tests applied in this study showed appropriate reliability and therefore may be used as appropriate and consistent testing procedures in evaluation of RAG and CODS in team handball. However, additional studies with greater sample conducted on different populations of handball players (youth, men and women) are necessary to assess test values in wider handball practice. It also

important to emphasize that construction of tests used in this study was limited just on agility performance during the attack transition game phase. Since reactive agility is more frequent and intense during positional game phases, constructing tests with features like this would be significant improvement in understanding agility performance in handball.

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