LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
2017, VOL.3, NO.451-461
DOI: 10.12973/ijese.2017.2140a

THE INFLUENCES OF SPEED, COD SPEED AND BALANCE ON REACTIVE AGILITY PERFORMANCE IN TEAM HANDBALL

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ABSTRACT

The aim of this study is to define the influence of linear speed, change of direction (COD) speed and balance ability on reactive agility test (RAT) performance in female team handball players. Further the relation of these abilities with each other. The research group is a group of female handball national team players (n=19, age=22.8±2.7 years). The anthropometric variables are height, weight, BMI, sitting height and leg length. To determine speed ability linear speed run is been used (10m=1.84±0.08s; 20m=3.31±0.15s; 30m=4.73±0.22s). For the COD speed, the pro-agility test was applied (5.45±0.22s), and for agility test the RAT (RATright=2.73±0.15s; RATleft=2.76±0.16s) was used. To determine the balance ability of the athletes, the Y-Balance test was applied by normalizing the leg length. At the end of the research, in which the result of the correlation statistic were use, it was obtained, that between the linear sped run and the COD test there is a significant relation (r=0.52, $p<0.05$). Where there was seen a significant relation between the RATright and COD speed (r=0.63, $p<0.05$), there was no significant relation with RATleft. As we compared the balance and RAT ability, whether there was no asymmetric issue between the right and the left leg balance ability of the research group, it was seen, that there was a significant relation level of right and left leg balance ability with the RATrigth (r=-0.57, $p<0.05$) but no significant with the RATleft (r=-0.17, $p>0.05$). Due to this results it was seen, that the linear speed ability of the female handball players has a relation to the COD speed but that it is not determinative for the RAT performance. So it was perceived that the traditional agility test (COD speed) planned, the RAT agility test planned and unplanned, because it is reactive, gives detailed information about the agility ability of the handball players. The balance is also influenced by the COD speed and by the RAT performance. In other words it can be stated that balance and speed training can improve the common agility ability performance of the athletes.

KEYWORDS
Reactive Agility, Balance, Speed, Change of Direction, Team Handball

ARTICLE HISTORY
Received 11 October 2016
Revised 14 December 2016
Accepted 16 December 2016

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Introduction

As an Olympic team sport it is important to have the suitable body size, highly developed motor skills such as speed, agility, strength, explosive power, endurance and technical skills for success at elite levels in team handball (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005; Mohamed et al., 2009; Saeterbakken, Tillaar, & Seiler, 2011).

Team Handball is a fast game and players are able to perform running, change of direction, jump and technical movement in very short time, faced to handle the tactical situation (Esfahankalati & Venkatesh, 2013). In their study, Póvoas and her collaborates (2012) selected the high intensity actions of an elite team handball match and they observed that 30% of stops, 30% of change of direction and one-on-one situations are main components of total most frequent high intensity playing actions.

At this point, it is obviously that agility is an important component of performance for many team sports (Young & Rogers, 2014) such as for team handball. Because, the agility tests are correlated to the structure of team handball it is known that they are often used to assess an essential performance parameter of handball players (Hermassi, Fadhloun, Chelly, & Bensbaa, 2011).

Two main components of agility are existing. One is change of direction speed, the second is perceptual and decision-making factors(Young, James, & Montgomery, 2002).A change of direction movement takes place in response to a stimulus. In all football codes, this stimulus includes movements from other players. So we are able to define agility as a rapid whole body movement with change of speed or direction in response to a stimulus (Sheppard & Young, 2006) like it is in team handball.

For this reason, we thought that to determine agility of team handball the reactive agility test (as sport-specific test) is able to reflect the game. As the reactive agility test is separated into segments it was seen that sprint speed and change of direction speed was ten meters for total running distance(Oliver & Meyers, 2009) and 2.73±0.15s. for average time.

In many different sports it has been proved, that there is a relation between balance ability and competition level and also in different performance measures (Hrysomallis, 2011). Actually because all the movements root from the balance ability, it is so important for each athlete such as for team handball players (Patel & Choudhary, 2016).

Tests with similar components in literature has been selected and their relation to the reactive agility test was investigated. These tests are 10-20-30 m sprinting speed (forward direction speed: 10m=1.84±0.08s, 20m=3.31±0.15s, 30m=4.73±0.22s), pro agility (change of direction speed: 18.28m=5.45±0.22s.) and Y-Balance (neuromuscular control, proprioception, flexibility, stability, strength).

The aim of this study was to predict the influences of linear speed, COD speed and balance on reactive agility performance in elite women team handball players.

Methods

Participants: A total of 19 female team handball players (age 22.8±2.7 years) who are national team players participated as volunteers in this study. The study was performed in accordance with the Declaration of Helsinki.

Procedures

Anthropometrics: The stature (BH) and body mass (BM) were assessed using a Seca stadiometer and weighting scales (Seca Instruments Ltd., Hamburg, Germany). Sitting height was measured using a Holtain stadiometer (Holtain Ltd., Crosswell, Wales, U.K.). The BMI was calculated as a ratio of the BM (kg) and squared BH (m).The athletes' right limb length was measured from the most inferior aspect of the anterior superior iliac spine to the most distal portion of the medial malleolus (cm).

Speed Tests: In order to determine the subjects' sprint ability running tests of 10-20-30 meter were performed. All results were recorded using photoelectric timing gates (Smartspeed, Fusionsport, Australia).

Change of Direction (COD) Speed (Pro-agility) Test: For the pro-agility test, which is also known as the 20 yard running test, pins were set 5 yards (4,57m) on the left and on the right side (Figure 1). A timing gate (Smartspeed, Fusionsport, Australia) was placed at the starting line. This way repeating passes were recorded. Before the test starts the athletes takes position. When the athlete is ready she is first touching the right pin, then the left pin, passes the starting line and finishes the test. For each athlete the total time was recorded (Dawes & Roozen, 2012).

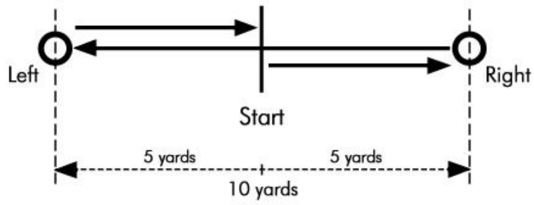

Figure 1. Diagram of the of pro-agility test

Reactive Agility Test (RAT): A diagram of the setup of the agility protocol is provided in Figure 2. Participants started all sprints from a position 30 cm behind the first timing gate. Sprint times were recorded using photoelectric timing gates (Smartspeed, Fusionsport, Australia). The timing instrumentation in the middle of the course was placed outside foam barriers, which were placed 1 m apart (Figure 2). The physical barriers were used to keep participants in a central position through the middle section of the course and to protect the timing equipment. Exit gates were placed at the left and right end of the test course for the agility sprints, the centre point of each gate was visually placed perpendicular to the intended line of running. Sprint times were recorded telemetrically, with all data transmitted to a personal digital assistant (PDA).

Each session began with a 10-min dynamic warm-up followed by the experimental protocol. Participants completed a number of sprints in the following order: two trials of a straight 10-m sprint, two trials (one to the left and one to the right) of a planned agility sprint, and repeated trials of a reactive agility sprint until either the participant had completed two sprints to either side or a total of eight sprints, whichever occurred first. As the change in direction in the reactive agility sprints was not under the control of the researcher, this approach meant there was a <1% chance that all reactive sprints would be in the same direction. In the planned agility run, participants were instructed which way to turn at the midpoint of test course before commencing each sprint. In the reactive agility test, the timing gate system dictated the direction in which participants proceeded having completed the first 5 m of the course. Upon breaking the beam of the timing gate in the middle of the course, lights on either the left or right exit gate flashed. Participants were required to react to this stimulus and sprint as quickly as possible through the illuminated timing gate. The delay time between breaking the beam in the middle timing gate and a stimulus light flashing was ~40 to 45 ms. During the reactive agility sprints, participants were instructed not to try to predict which exit gate they would be required to sprint through; to ensure that this did not occur, the investigator visually monitored technique and compared reactive performance times to planned sprint times.

The best single effort from the straight 10-m sprint was used for analysis. The mean of the efforts to the left and right was used as a measure of planned agility. For the reactive agility, the best two efforts to each side were taken, or when this was not possible either a single effort or no result was recorded to a particular side. Reactive agility results where then considered as the overall mean, the mean to both the left and the right, and the best effort to both the left and right(Oliver & Meyers, 2009).

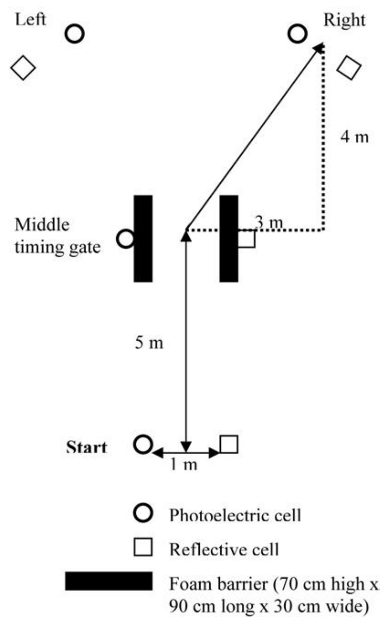

Figure 2. Diagram of the experimental setup for measuring reactive agility sprint speed (modified from Oliver & Meyers, 2009).

Lower Quarter Y-Balance Test (YBT-LQ): YBT-LQ collection occurred using a previously established standardized testing protocol that has shown to be reliable. First, the subjects viewed a standard video demonstration followed by six practice trials prior to testing. Afterwards, all subjects performed the YBT-LQ with shoes off in an effort to decrease the possible influences footwear may have on balance. The subject began the test by standing with one foot on the stance plate with the most distal aspect of the foot at the starting line, and then was asked to reach with the opposite leg in the anterior (forward), posteromedial (back and out to the side of the reaching leg), and posterolateral directions (back and behind the side of the stance leg). The testing order was 3 trials standing on the right foot reaching in the anterior direction (right anterior reach) followed by 3 trials standing on the left reaching in the anterior direction. This procedure was repeated for the posteromedial and then the posterolateral reach directions. During the trials, the reach foot was not allowed to touch down on the floor or gain balance from the reach indicator or support pipe. If the subject was unable to perform the test according to the above criteria in six attempts, the subject failed that direction, no data were collected and another trial was conducted.

Reach distance was measured from the most distal aspect of the toes of the stance foot to the most distal aspect of the reach foot in the anterior, posteromedial, and posterolateral directions. The greatest reach of three trials for each direction, for each leg, was used for analysis. Reach distances were normalized to limb length, using the measured distance from the ASIS to medial malleolus in supine. A composite reach score was obtained by taking the average of the normalized reach scores ([Normalized Anterior+ Normalized Posteromedial + Normalized Posterolateral]/3). Reach symmetry was also assessed by obtaining the difference in the absolute reach distance between left and right sides for all reach directions(Gorman, Butler, Rauh, Kiesel, & Plisky, 2012).

Statistical Analyse: The standard statistical parameters (mean, SD, and range) were calculated for each tests. Pearson correlation statistic had been used for the relation between the tested variables on the research group. Statistical significance was set at $p<0.05$. For the statistical procedure SPSS 17.0 pocket program was applied.

Test of normality result were calculated in Table 1. Although total participant count is nineteen, parametric statistic has been used according to the results ($p>0.05$).

Table 1. Test of Normality for the research group

	Shapiro-Wilk		
	Statistic	df	Sig.
10 m	.963	19	.63
20 m	.957	19	.51
30 m	.950	19	.40
Pro Agility	.967	19	.71
RAT - R	.926	19	.15
RAT - L	.956	19	.50
YBT - R	.955	19	.48
YBT - L	.971	19	.80

Results

Descriptive and performance characteristics of study group are presented in Table 2. The comparison of speed, agility and balance ability of the study group are presented in Table 3. There is an obviously middle level, positive and statistical relation between the COD speed ability and the linear speed values of the participants (r=.52/.49/.46, $p<0.05$). According to this evidence it can be said that there is a relation between the agility of the female handball players and their sprinting speed performance. The more their speed values decrease, the more their COD speed agility is decreasing as well.

Table 2. Descriptive and performance characteristics (Mean±SD) of the study group

	Mean ± SD	Min.	Max.
Age (years)	22.8 ± 2.7	18.5	26.1
Training years (years)	12.1 ± 2.5	9	16
BM (kg)	64.6 ± 4.5	53.4	75.5
BH (cm)	172.8 ± 3.5	166.8	178.6
BMI (kg/m^2)	21.6 ± 1.4	18.5	24
Sitting height (cm)	91.7 ± 2.6	85.8	95.9
Leg Lenght (LL) (cm)	92.4 ± 2.9	88	98
Speed			
10 m (sec)	1.84 ± 0.08	1.66	2.02
20 m (sec)	3.31 ± 0.15	2.98	3.64
30 m (sec)	4.73 ± 0.22	4.26	5.26
Change of direction speed			
Pro Agility (sec)	5.45 ± 0.22	5.04	5.80
Reactive agility			
RAT-R (sec)	2.72 ± 0.13	2.55	3.00
RAT-L (sec)	2.76 ± 0.16	2.50	3.10
Y-Balance Test			
YBT – Composite Reach Score – R (%LL)	82.78 ± 4.22	72.4	89.5
YBT – Composite Reach Score – L (%LL)	82.88 ± 4.14	72.8	91.0
YBT – Composite Reach Score (%LL)	82.84 ± 4.14	72.6	90.3
Anterior Difference (cm)	-0.05 ± 1.39	-3.0	2.0
Posteromedial Difference (cm)	0.37 ± 2.19	-3.0	3.0
Posterolateral Difference (cm)	-0.58 ± 1.68	-3.0	5.0

R= Right; L= Left; COD= Change of direction; RAT= Reactive Agility test;
YBT= Y-Balance test; %LL=Percent Leg Length

Also there is a middle level positive and significant relation between the COD speed and the RAT-R values (r=0.65, p<0.05) but no statistical significant relation could be found with the RAT-L value (r=.23, p>0.05). According to this founding the COD speed and the RAT right run is more efficient. However this can be explained with the right sign of the COD speed test (pro-agility test) protocol it is still seen that there is a asymmetry in the relations between the balance values and the RAT performances.

Between RAT R, YBT-R and YBT-L is a middle level negative, statistical and significant relation (r=-.57/-.51, p<0.05). Due to this finding the YBT-R and YBT-L balance agility of a person with good balance the RAT-R is decreasing, but there is a significant relation between RAT L, YBT-R and YBT-L (r=-.32/ -.17, p>0.05). In other words the balance ability for athletes, which have (both legs) in good condition, are increasing their RAT performance in on the right direction.

Table 3. Relationship among speed, COD speed and reactive agility in female handball players

	10m	20m	30m	Pro Agility	RAT R	RAT L	YBT R	YBT L
10 m	1							
20 m	.98**	1						
30 m	.95**	.99**	1					
Pro Agility	.52*	.49*	.46*	1				
RAT - R	.37	.27	.23	.65**	1			
RAT - L	.33	.26	.25	.23	.53*	1		
YBT - R	-.14	-.05	-.02	-.41	-.57*	-.32	1	
YBT - L	-.77	.01	.05	-.46*	-.51*	-.17	.99**	1

R= Right; L= Left; COD= Change of direction; RAT= Reactive Agility test; YBT= Y-Balance test

Data are reported as Pearson product moment correlation coefficients, r.

* Denotes significance at p<0.05.

** Denotes significance at p< 0.01.

Discussion

The aim of this research is to find out the influence of speed, COD speed and balance in reactive agility the performance in team handball. In additional, speed, COD speed, balance, and reactive agility values and their relation to each other.

Relationships between speed and standard agility range from low values (0.27–0.32) (Bayraktar, 2013; Salaj & Markovic, 2011; Sekulic, Spasic, Mirkov, Cavar, & Sattler, 2013) to moderate correlation coefficients (0.52–0.73) (Pauole, Madole, Garhammer, Lacourse, & Rozenek, 2000). In this study it has been found that there is a relation between the standard agility test pro-agility values and linear speed values in a middle level positive and statistical significant relation (r=.52/.49/.46, $p<0.05$). Even if in the research different type of protocols have been used, there is a high correlation between the tests (Stewart, Turner, & Miller, 2014). Further in this study there has been found no significant relation between reactive agility test and speed.

Like there are studies who have the same results as we found through our work (Lockie, Jeffriess, McGann, Callaghan, & Schultz, 2014) there are also studies which prove that there are middle and low lever relations (Gabbett, Kelly, & Sheppard, 2008; Sheppard, Young, Doyle, Sheppard, & Newton, 2006).

When we investigate the traditional agility tests commonly they are COD speed tests (Cooke, Quinn, & Sibte, 2011). In nowadays much more planed and reactive agility test are used for different sports. In this study the COD speed test and the reactive agility test has been used. Analysing the relation between these two test it has been obviously that between RAT right and COD speed there is a middle level relation (0.65, $p<0.05$). In many different test there was no relation between COD speed and reactive agility test results found (Scanlan, Humphries, Tucker, & Dalbo, 2014; Spiteri et al., 2014).

There were less researches found for balance and agility relation. Researchers always emphases, that it is necessary for improving agility, balance ability has to be improved as well. (Sporis, Jukic, Milanovic, & Vucetic, 2010). In another study it has been shown that there is a significant influence from balance and speed ability on agility and this research proves the middle level relation of COD speed and balance in women (0.37) (Sekulic et al., 2013). The results of this research are also upheld by literature. Even if there was an asymmetric issues of the participant of this test it was searched out that the agility (RAT) ability in handball (Póvoas et al., 2012) there was a unilateral (right) dominant situation. Such a study has not been found in the resources.

In conclusion it has been found in this research that there is a relation between the linear speed ability of the female handball players and their COD speed ability but that it is not significant for their RAT performance. Traditional agility tests (like COD speed) are planned, whereas RAT is reactive. Due to the fact that RAT gives detailed information about the agility ability of the team handball players. It is obviously that the balance influences the COD speed and also the RAT agility performance. In other words it can be addressed that balance ability and linear speed workout is able to improve the common agility ability performance of handball players.

Disclosure statement

No potential conflict of interest was reported by the author.

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