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Relationship between Sprinting, Change of Direction and Jump Ability in Young Male Athletes

Ilias Zapartidis[1], Vasilia Makroglou[1], Magdalini Kepesidou[1], Ana Milacic[2], Aliki Makri[1]

Abstract

Objectives: To identify the relationship between sprinting, jump ability and change of direction, in a large sample of young male handball players. **Methods:** 151 handball players (13.39 ± 0.61 yrs, height 1.67 ± 0.09 m, weight 60.90 ± 12.29 kg) performed a series of motor tests: sprinting (5-m, 10-m & 30-m), jumping ability (standing long jump and jump-and-reach), 5-0-5 agility, 30-m dribble and defensive sliding movement. **Results:** The main findings of the study indicate different levels of correlation coefficients among acceleration (5 and 10-m), sprinting ability in 30-m, jumping ability and changes of direction with and without the ball. Coefficient of determination showed that only six of the bivariate distributions could explain the association between the examined parameters with strength of more than 50%. Specifically, the coefficient of determination values between the linear sprints were the greatest (57.8–88.5%), followed by the respective one between the jump tests (85.6%). Jump tests showed a higher coefficient of determination with the 30-m sprint (standing long jump r^2 = 63.2%, jump & reach r^2 = 59.4%). The results of this study suggest that specific tests must be used for the performance evaluation of various motor skills.

Keywords: handball, adolescent athletes, agility, fitness testing, speed

1. Introduction

Competitive handball is a team sport which requires a great exertion. Fundamental basis of success in handball is a blend of high aerobic and anaerobic capacity. Moreover, sprinting, jumping ability, acceleration and agility are crucial for the players' effectiveness during the game. (Chelly et al., 2011) Players execute explosive actions such as blocks, jumps, changes of direction (COD) and stops combined with technical skills, with or without the ball. In addition, these skills combined with throwing capacity are a key factor in detecting talented athletes. (Palamas et al., 2016; Zapartidis et al., 2011)

A relatively recent study (Chelly et al., 2011), showed that elite adolescent players during the game perform average 501 ± 47 movement changes (approximately one change every 6 sec), and perform 38 ± 6 sprints, with average duration 2,0 ± 0,6 sec. The same researches remark that a number of 45.9 ± 7.7 and 42.8 ± 7.2 jumps are performed during first and second half respectively. On the other hand, agility-COD is considered to be an important quality factor required by the players who participate in all team sports. (Paul et al., 2016)

Similarities in morphological, biochemical and biomechanical components which define jumping ability, sprinting and COD, have led to the assumption that these qualities are highly correlated. (Vescovi & Mcquigan, 2007; Little & Williams, 2005) However, studies relating to the interdependence of the properties of sprinting, jumping ability and COD, shows contradictory results and therefore some areas require more research. (Negra et al., 2017; Paul et al., 2016; Erikoglu & Arslan, 2016; Sheppard & Young, 2005) Moreover, running speed in combination with performing a technical skill (i.e., dribble) seems to further increase the complexity of a test. (Erikoglu & Arslan, 2016; Tsitskarsis et al., 2003)

[1] MSc, National and Kapodistrian University of Athens, School of Physical Education & Sports Science, Greece.
Email: elzapa@phed.uoa.gr
[2] University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro.

Field tests are broadly used to evaluate the performance in young athletes, and mainly include running speed, jumping ability, and COD. Minimum equipment is required to perform these tests, as they include common and simple motor skills, and can be applied by all the trainers in the teams. For a more accurate definition of the relationship between these abilities in young handball players, a research on a large number of subjects should be performed. Thus, the purpose of this study was to identify the relationships between sprinting, jump ability and change of direction (dribbling and without dribbling), in a large sample of young male handball players.

2. Materials and Methods

2.1 Participants

151 pre-adolescent handball athletes were evaluated in various tests as part of their athletic plan during the competitive season (Table 1). Athletes and their parents had been given a full explanation of the procedures in advance, and consent was obtained before the tests. The dribbling and jump-and-reach tests were not included in all measurements. All athletes were free from any injury that would prevent maximum effort during these performance tests.

Table 1. Descriptive characteristics of the sample

	Mean ± SD	Range	N
Age (yrs)	13.39 ± 0.62	11.89-14.89	151
Stature (m)	1.67 ± 0.09	1.44-1.90	151
Body mass (kg)	60.90 ± 12.29	36.80-95.70	151
5-m sprint (s)	1.21 ± 0.13	1.00-2.07	151
10-m sprint (s)	2.04 ± 0.15	1.74-2.40	151
30-m sprint (s)	4.96 ± 0.35	4.14-5.91	151
5-0-5 agility (s)	2.90 ± 0.20	2.47-3.46	151
Standing long jump (cm)	190.12 ± 23.66	140.0-251.0	151
Jump & reach (cm)	46.91 ± 7.62	32.0-62.0	129
30-m dribble (s)	7.43 ± 0.74	6.09-10.13	129
Defensive triangle (s)	14.33 ± 0.58	4.20-7.03	151

2.2 Measurements and Procedures

Running speed and acceleration were evaluated over 30 meters, with split times at 5 m, 10 m and 30 m. Jumping ability was evaluated through standing long jump and jump-and-reach test. The jump-and-reach test is powerful in situations where reaching the height during flight phase is critical for sports such as handball. (Menzel et al., 2010) Agility skills were evaluated through three different performance tests: a) a 5-0-5 agility - change of direction test (Sheppard and Young, 2006), b) a handball specific defensive sliding movement (triangle) was used to assess handball technical speed-agility-change of direction skill (Mohamed et al., 2009) and c) 30 m obstacle slalom dribbling test was used to assess player's speed-agility with the ball. (Lidor et al., 2005) All tests were performed twice with 3 min rest between trials and 5-6 min between tests, the best trial was used for statistical analysis. The sprint and agility performances were recorded using electronic photocells (Brower Timing System, Salt Lake City, UT).

2.3 Statistics

Descriptive statistics (means and standard deviations) were applied to all variables. Pearson product – moment correlation coefficients (r) were calculated for the entire sample as well as separately for boys and girls. For the explanation of the meaningfulness of the relation between tests the coefficients of determination (r^2 x 100) were used. The level of statistical significance was set at $p < 0.05$. With large samples, the issue of the correlation becomes increasingly relevant, and it may be statistically different from zero, but the magnitude of the relation may be thought of as quite small. (Meyers, Gamst and Guarino, 2006) Hopkins (2006) has suggested that an absolute correlation coefficient of 0.11–0.30 is considered small, 0.31–0.5 moderate, 0.51–0.7 large, 0.71–0.9 very large, and 0.9–0.99 nearly perfect.

From the other hand, Vincent (1999) has proposed that a correlation of 0.5-0.7 is considered low, 0.7-0.8 moderate and 0.9 or above is considered strong. Thus, for the current study the optimum values for Pearson correlation coefficients were < 0.7 low, 0.71-0.89 moderate, and 0.9 or above strong.

3. Results

Table 2 displays the Pearson product – moment correlation coefficients for all measured variables. The performances on all individual assessment tests for acceleration, speed, jumping ability, and agility - COD, were all correlated at high levels of statistical significance ($p < 0.001$). 30-m speed-agility with the ball has shown the weakest statistical significance correlations with 5-m acceleration ($p = 0.002$) and jump & reach test ($p = 0.013$). However, the Pearson product – moment correlation coefficients between the most of the various tests were weak to moderate ($r = 0.272$ to -0.795). The negative correlations indicate that the performance tends to improve as the time to cover the distances gets shorter. As expected, sprint split times showed the most significant correlations between each other ($r = 0.760$ to 0.941). The strongest correlations were found between 5-m and 10-m performances ($r = 0.941$) and between 10-m and 30-m performances ($r = 0.919$). Also, the two tests that evaluated the explosive power of the lower extremities (standing long jump and jump & reach) were found to be strongly correlated with each other ($r = 0.925$).

Table 2. Pearson product – moment correlation coefficients.

	5-m	10-m	30-m	5-0-5	SBJ	JRT	30-mD	DTA
5-m	1.0							
10-m	0.941*	1.0						
30-m	0.760*	0.919*	1.0					
5-0-5	0.395*	0.511*	0.615*	1.0				
SLJ	-0.515*	-0.697*	-0.795*	-0.618*	1.0			
JRT	-0.624*	-0.704*	-0.771*	-0.529*	0.925*	1.0		
30-	0.272#	0.312*	0.326*	0.529*	-0.359*	-0.290†	1.0	
DTA	0.418*	0.514*	0.594*	0.571*	-0.584*	-0.487*	0.469*	1.0

* $p < 0.001$; # $p = 0.002$; † $p < 0.05$

Note: SLJ = standing long jump; JRT = jump & reach; 30-mD = 30-m slalom dribble; DTA = defensive triangle.

Table 3. Coefficients of determination (%) among variables.

	5-m	10-m	30-m	5-0-5	SLJ	JRT	30-mD	DTA
5-m	-							
10-m	88.5	-						
30-m	57.8	84.5	-					
5-0-5	15.6	26.1	37.8	-				
SLJ	26.5	48.6	63.2	38.2	-			
JRT	38.9	49.6	59.4	28.0	85.6	-		
30-	7.4	9.7	10.6	28.0	12.9	8.4	-	
DTA	17.5	26.4	35.3	32.6	34.1	23.7	22.0	-

Note: SLJ = standing long jump; JRT = jump & reach; 30-mD = 30-m slalom dribble; DTA = defensive triangle.

4. Discussion

The purpose of this study was to determine the relationship among basic motor characteristics of pre-adolescent handball athletes. The main findings of the present study indicate different levels of correlation coefficients among acceleration (5 and 10-m), sprinting ability in 30-m, jumping ability and changes of direction with and without the ball in pre-adolescent handball players.

Our results are in agreement with previous studies that did not find any correlations among acceleration, running speed, jump performance and agility with and without the ball in young soccer players. (Erikoglu & Arslan 2016; Koklu et al., 2015) Considering only the statistical significance of the bivariate distributions, this might suggest that either these tests evaluate similar characteristics, or performance on a specific test could possibly predict performance on another test as well. (Vescovi & McGuigan, 2007)

However, our findings on the coefficient of determination showed that for the sample used in the present study, only six of the bivariate distributions were applied in the analyses could explain the association between the examined parameters with a strength of more than 50% (Table 3). Specifically, the coefficient of determination values between the linear sprints were the greatest (57.8–88.5%), followed by the respective one between the jump tests (85.6%). Little and Williams (2005) have reported that performance in 10-m sprinting and agility were distinctive features in a group of professional football players. An earlier study, stated an explained variance of 52% between 10-m and 40-m sprint times in professional rugby players (Baker & Nance, 1999), while Vescovi & McGuigan (2007), have reported a greater amount of explained variance (r^2 = 60 - 78%) between 9.1-m and 36.6-m sprints, when they tested high school and collegiate lacrosse and soccer players.

Muscular strength and power of the lower limbs plays an important role in handball and is a main factor in developing various motor movements which are performed during training as well as during the game. (Zapartidis et al., 2009) Coaches and trainers use the standing long jump and jump & reach tests as an indirect measure to assess strength of the lower limbs. Present results showed that performance in both jumps was inversely correlated to sprint times in 5-m, 10-m and 30-m, indicating that the greater the explosive power of the lower limbs, the lower the time spent in the sprints. Both jump tests showed a higher coefficient of determination with the longer sprint distances (r^2 = 30-m 59.4 and 63.2%; 10-m 49.6 and 48.6%; 5-m 38.9 and 26.3%). The results are in agreement with an earlier study that examined female soccer players, stating that performance in the countermovement jump showed a weak to moderate correlation to sprint times, with the relationship becoming, stronger as the sprint distance increase. (Vescovi and Mcguigan, 2008) Yanci, et al., (2014) also reported weak to moderate association of short sprint tests (5, 10 and 15m), with the countermovement and horizontal jump (r = 0.20 to 0.50) of male soccer players, with an increasing strength in the relationship as the travelled distance increased. Furthermore, other studies have reported weak relationships between jump performance and linear sprint distances in rugby and female track and field athletes (r = -0.56 to -0.62 and -0.55 to -0.64 respectively). (Cronin & Hansen, 2005; Hennessy & Kilty, 2001)

For a sport such as team handball, agility-COD skills are particularly important for success and should be developed during training and physical conditioning programs. The explained variance between the COD tests (5-0-5 and defensive triangle) was only 32.6% suggesting that these two specific tests evaluate different skills (Table 3). In addition, the two COD tests showed a low coefficient of determination with all the variables examined (r^2 = 17.5 to 38.2%). A recent study, involving twenty-four young soccer players aged 14 years, reported similar determinants between zigzag agility test and countermovement (r^2 = 34%), squat (r^2 = 36%) and drop jump (r^2 = 35%) test. (Erikoglu & Arslan, 2016) An earlier study (Webb & Lander, 1983), showed no significant correlations between L-run COD test and the standing long jump (r = -0.35) or the vertical jump (r = -0.19). Additionally, Salaj and Markovic (2011), reported generally low coefficient of determination values between COD tests and jump tests (r^2 = 0.16 to 10.9%) as well as between agility-COD tests and sprint tests (r^2 =1.21 to 18.5%). Based on previous studies and present results, it appears that muscle strength and power as assessed by various jump tests are poor predictors of agility-COD speed.

In team sports, mainly aim is possession of the ball, and therefore complex skills such as dribbling and controlling the ball are required. However, it seems that sprinting while performing such a skill (i.e.: dribbling) since the required coordination to execute the task will be increased. (Sheppard & Young, 2006) Consequently, performance of the athlete upon handling the ball might be affected. Kong et al., (2015) found that performance on the Yo-Yo test with dribbling was moderately correlated with that of the Yo-Yo test without dribbling (r = 0.57). On the other hand, Tsitskarsis et al., (2003) reported a weak correlation between sprinting ability and dribbling a basketball, which was attributed to the reduction of speed during dribbling or agility. Similarly, Erikoglu and Arslan (2016) did not find any significant correlations between a directional change - zigzag agility test with the ball as well as with sprinting and jumping ability in a sample of young soccer players. Taken together these results underline the complex nature of the relationships between the various physical performance tests.

In the current study, it could be argued that the complexity of the relationships was manifested by the relatively low explained covariance among the examined variables. In team handball, speed is manifested in combination through a variety of motor activities that are performed at a fast or explosive rate and include offensive and defensive jumps, blocks, sudden stops or directional changes and dribbling with the ball. Sprint times typically last between 2-6 sec and all these explosive actions are essential elements of success. In order to perform these kinetic activities, glycolytic kinetic units (IIb) are activated and have implications for the short-term energy system and the central nervous system. (Brown & Ferrigno, 2005).

Although there appear to be similar morphological and biomechanical components among the afore-mentioned performance tests, performance in a sporting task is extremely complex. It requires a high frequency of excitation of fast motor units but also a simultaneous activation of slow motor units by synchronizing many parts of the body. (Sleivert et al., 1995) Successful performance also demands for high coordination ability and to be able to alternate between upper and lower extremity movements at a high velocity. Moreover, an athlete's ability to execute efficiently various kinetic actions during the game depends on cognitive factors, such as perception and prediction ability along with a visual processing capability and short reaction time.

6. Conclusion

In conclusion, this study examined the relationships among sprinting, acceleration, change of direction, dribbling, agility and jumping ability in 13-14 year old handball players. The results of the present study suggest that specific tests should be used for the performance evaluation of various motor skills. Optimization of competitive performance in sports such as handball, requires that specialized training stimuli of explosive-, ballistic- and plyometric-type exercises should be used, comprising of kinetic efforts which simulate the movements in team handball. These results are to be taken into account considering that the correlation analysis does not imply the cause-effect relationship. In addition, other measurements that include somatometric features and aerobic and anaerobic performance are also necessary for the assessment of performance in young athletes in handball.

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