

## VALIDITY OF NEW HANDBALL AGILITY TEST: ASSOCIATION WITH SPECIFIC SKILLS AND MUSCULAR EXPLOSIVE DETERMINANTS OF LOWER LIMBS IN YOUNG HANDBALL PLAYERS

Souhail Hermassi<sup>1</sup>, Chelly Mohamed Souhail<sup>1</sup>, Georg Fieseler<sup>2</sup>, El Ghali Bouhaf<sup>3</sup>, Stephan Schulze<sup>4</sup>, Birgit Hoffmeyer<sup>5</sup>, Lars Irlenbusch<sup>4</sup>, Karl-Stefan Delank<sup>4</sup>, René Schwesig<sup>4</sup>

### ABSTRACT

The aims of the study were to assess the reliability and validity of a new handball agility test (HAT), and to evaluate the association between the test and the explosive performance measurements of lower limbs in young handball players. 72 young handball players ( $15.6 \pm 0.4$  years) participated in this study. All players conducted the HAT using a modified ZIG ZAG course consisting of three 5-m sections set out at  $100^\circ$  angles. Electronic timing gates were used to record completion times. To assess the reliability of the HAT, each player performed the tests twice, on separate days. The criterion validity of the HAT was determined by examining the relationship between the HAT performances and two popular agility tests performances (T-half test and the Illinois test). Participants also underwent measurements squat and counter-movement jumps, sprinting velocities on 5-m (V5) and 10-m (V10), and handball specific skill test (HST). The results showed no difference between test–retest HAT scores. Intra class reliability of the HAT was greater than 0.91 across the trials (0.92 and 0.97, respectively). The HAT was closely related to both the T-half test and Illinois agility tests ( $r = 0.52$  and  $r = 0.68$ ,  $p < 0.05$ ). Relevant correlations were found between HAT, CMJ and SJ ( $r = 0.58$  and  $r = 0.38$  respectively;  $p < 0.01$ ). A very large association were also found between HAT and V5-m and V10-m ( $r = 0.60$  and  $r = 0.55$  respectively;  $p < 0.01$ ). The HAT constitutes a reliable and valid field tool for assessing short term running agility in young team handball players. Therefore, is very suitable for monitoring athletic performance of the lower-limbs in young handball players.

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**Keywords:** Agility test; handball, young players, sprint tests, change direction.



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## Introduction

The ability to rapidly change direction and react to different stimuli is a particularly important requisite in team handball <sup>[1,2]</sup>. When examining a variety of anthropometric, physiological, psychological, and skill components in elite and sub-elite youth handball players, it has been reported that agility is the most discriminating factor <sup>[3,4]</sup>. The capacity of handball players to produce varied agility and speed actions is known to impact handball match performance <sup>[5, 6]</sup>, and both does in fact constitute the more crucial moments of the game and contribute directly to winning possession of the ball and to conceding of throwing ball <sup>[5]</sup>. The high performance in various change of direction (COD) tests in handball players, compared with both the general population and the higher standards of handball, indicates that COD and agility attributes are advantageous for elite handball players <sup>[7]</sup>. The COD actions during handball competition can be categorized into actions requiring acceleration, maximal speed, or agility. Agility it is often recognized as the ability to change direction and start and stop quickly <sup>[2]</sup>.

A great interest exists for developing field tests and specific training protocols that can effectively measure and improve agility <sup>[8]</sup>. The ability to rapidly change direction tests

supported to assess players' agility are tests based on change of direction speed [e.g., the Illinois agility test, the T-test, , the 505 test, the L-run test, and the zigzag test]. The most used test to assess agility was the T-test [9, 10, 11]. The T-test involves speed with four directional changes, and it is simple to administer and requires minimal equipment and preparation.

Considering the importance of repetitive explosive actions and winning challenges in handball, the talent identification process usually involves a physical (i.e., anthropometry) and physiological (i.e., performance measures as speed, strength, aerobic and anaerobic power) testing battery relevant to the demands of the handball activity. However, a one dimensional approach in talent identification based on physical and physiological parameters can be misleading. Rather, a multidisciplinary approach addressing physical, physiological, technical and psychological predictors should be conducted [12, 13]. An important issue is that excellence in a sport is not dependent on one standard set of skills, but can be achieved in unique ways through different combinations of abilities. It has been suggested that variables such as high COD abilities may also be of importance in talent identification and development in youth handball [12, 13]. However, there has been no study so far that could show the contribution of these capacities in young handball players while using of the HAT as protocol comprehends

actions from some of the physical capacities above. We hypothesized that the HAT, like the T-half test and Illinois test, would provide stable test–retest scores, and it would have a stronger relationship with sport specific skills and muscular explosive determinants of low limb in young handball players.

## Methods

### Study design

This study was designed to assess the reliability and validity of HAT, and to evaluate the association between this test and the athletics measurements of lower limbs in young handball players. Before any baseline testing, all participants attended a familiarization session to be introduced to the testing procedures and also to ensure that the learning effect was minimal for the baseline measures. Measurements included two popular agility test (i.e., T-half test and Illinois test), SJ, CMJ, 5-m and 10-m sprint test. All tests were conducted at the same time of the day (5-7 P.M.), and took place during the competitive season (two months after the beginning of the national championship). All tests were conducted on an indoor handball court, where ambient temperature ranged from 18 to 22° C. To reduce the interference of uncontrolled variables, all the subjects were instructed to maintain their habitual lifestyle and normal dietary intake before and

during the study. The subjects were told not to exercise on the day before a test and to consume their last (caffeine-free) meal at least 3 h before the scheduled test time.

## Subjects

Seventy-two male out-field team-handball players (age:  $15.8 \pm 0.3$  years, body mass:  $75.9 \pm 8.1$ kg, height:  $1.78 \pm 0.05$  m, body fat:  $12.4 \pm 1.2\%$ ) volunteered for this study. Participants had at  $5.6 \pm 0.4$  years of experience in handball. The normal weekly training routine of the players consisted of four training sessions (~ 60 min each session) and one competitive game per week. The training background of the players was focused on handball-specific training (i.e. technical and tactical skills), aerobic and anaerobic training (i.e. on- and off-court exercises), and strength training. Before any participation, the experimental procedures and potential risks were fully explained to the subjects, and they all provided written informed consent. Parental / guardian consent for subjects under 16 years old was obtained. The study was approved by the local research ethics committee and conformed to the recommendations of the Declaration of Helsinki.

## Procedures

*Warm-up and Trial Performance.* The standardized warm-up required participants to perform five minutes of jogging, followed by four runs through the test being performed

that day at approximately 50, 60, 70, and 80% of perceived maximum effort to warm-up the specific muscle groups required for the movements involved. Each run through was separated by 60 s recovery. A four-minute period of static stretching of the quadriceps, hamstrings, gastrocnemius and soleus muscle groups was carried out following the sub maximal runs and before the three experimental trial runs. This was the preferred standard practice of the handball players recruited and was therefore used for all participants to standardize pretest conditions. Participants were instructed to perform each of the three experimental trial runs on all agility tests “T-half test” a “3-2-1 Illinois tests” and “HAT test” countdown. Two minute recovery periods were allowed between each trial run to minimize the effects of fatigue on subsequent attempts.

*The New handball Agility Test.* This zigzag test was chosen and modified in HAT using a short course four 5-m sections set out at 100° angles because it required acceleration, deceleration, and balance control facets of agility and also dribbling a ball with the hand (Figure1) (i.e. activities that characterize match play in younger team handball) [12, 13, 14]. The familiarity of the subjects with the test and its relative simplicity also meant that we expect the learning effects to be minimal. Tests were conducted in this order: agility test with dribbling ball and without dribbling ball. Subjects performed two trials of each test, with at least 2 minutes of rest between all trials and tests. Electronic timing gates were

used to record test completion times (Microgate Race time 2 Light Radio, Bolzano, Italy). The best performances in each test were used for analysis. All tests were conducted at least 48 hours after a competition or hard physical training to minimize the influence of fatigue on test performance.

**\*\*\*Insert figure 1 near here \*\*\***

The modified agility T-half test was performed using the same directives protocol of the T-test, except that the total distance covered and measures of inter-cone distance were modified. However, the numbers of directional changes were maintained the same <sup>[15]</sup>. Subjects covered a total distance of 20 m on the present modified T-test (instead of 36.56 m as on the original T-test). Criteria for accepted test trials were the same as those used on the T-test. The recorded score for this test was the better of two last trials (test–retest session).

Illinois agility runs. Participants began from a standing start, and following a “3-2-1” countdown ran the course with maximum effort without knocking over any cones. The Illinois agility test was used to determine the ability to accelerate, decelerate, turn in different directions, and run at different angles. These tests were selected based upon established criteria data for males and females and because of their reported validity and



reproducibility of the tests <sup>[16]</sup>. Participants were encouraged to complete the course as fast as possible and performance time was recorded in the same manner as the SCODS test.

Straight Sprint test (V5-m and V10-m). Acceleration speed was evaluated using a straight sprint test, involving sprinting V5m and V10m as fast as possible from a stationary start position. Subjects were instructed to begin with their preferred foot forward, placed on a line marked on the floor from a standing position. The subjects performed three test trials. The recorded time for this test was the better of the two last trials.

Squat and Countermovement Jump was determined using a force platform (Quattro Jump, version 1.04, Kistler Instrument AG, Winterthur, Switzerland). During the test, participants performed 4 maximal CMJ and SJ, respectively, with a rest period of at least 30 s between jumps. The subjects were instructed to perform the jumps with maximal effort in order to achieve explosive force production and maximal jump height. The best trial in terms of maximal jumping height was used for further analysis.

*Handball skill test.* Speed, agility, and handball skills were tested by a slalom dribbling test. Subjects ran a distance of 15 m, back and forth, dribbling a handball around 5

cones. The distance between the starting line and the first cone, as well as between the other cones, was 3 m. Subjects ran individually <sup>[17]</sup>. The better of 2 trials was recorded for statistical analysis. All tests were performed on an indoor synthetic pitch, and electronic timing gates (MicrogateRace time 2 Light Radio, Bolzano, Italy) were used to record times.

### Data Analysis:

Findings are reported as means  $\pm$  standard deviations (SD). The reliability of jump tests (SJ and CMJ), running velocity and the handball skill test were assessed using intraclass correlation coefficients (ICC). Confidence limits (95%) for CV and ICC were calculated using Chi-square, and McGraw and Wong (1996) estimates, respectively. Pearson's product moment correlations and linear regression analyses were used to examine relationships between handball agility test performance and other measures of physical ability. Correlation coefficients were interpreted in accordance with the following scale of magnitudes as devised by Cohen (1988):  $r < 0.1$ , trivial;  $0.1 \leq r < 0.3$ , small;  $0.3 \leq r < 0.5$ , moderate;  $r \geq 0.5$ , large. Significance was assumed at 5% ( $p \leq 0.05$ ). All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) (version 19.0 software for windows).

## Results

### *Reliability and Validity*

To assess the reliability of the HAT, each player performed the tests twice, on separate day's (Table 1). Reliability data for all measures are presented in Table 2. The criterion validity of the HAT was determined by examining the relationship between HAT and two agility tests performances (T-half test & Illinois test). Measures of fastest time showed very good test-retest reliability as evidenced by the low coefficients of variation and high intraclass correlation coefficients (Table 2). However, the coefficients of determination show that even the most significantly correlated tests, acceleration, share only 39% common variance. Hopkins (2000) state “when common variance between the two variables is less than 50%, it indicates that they are specific or somewhat independent in nature.” As such, it appears that acceleration, jumping and agility are relatively independent attributes in young handball players. The requirement of high power production during each of the three tests, which itself partly depends upon the ratio of leg strength to body mass and fiber type proportion, means that the different speed components do indeed share some relation. However, our results suggest that some different factors contribute to successful performance in each speed discipline.

**\*\*\*Insert tables 1 & 2 near here\*\*\***

The data obtained for all performance parameters are presented in table 3. The HAT was closely related to both the T-half test and Illinois agility tests ( $r = 0.52$  and  $r = 0.68$ ,  $p < 0.05$ ; Table 4; Figure 2). Moderate correlations were also shown between HAT, sprint V5m and V10 m ( $r = 0.60$  and  $r = 0.55$ ,  $p < 0.01$  respectively (Table 4; Figure 3). The HAT was significantly correlated with CMJ and SJ ( $r = 0.58$ ,  $p < 0.01$  and  $r = 0.38$ ,  $p < 0.001$ , Table 4). Therefore a significant association was observed for the HAT and handball specific skills ( $r = 0.52$   $p > 0.05$ , Table 4; Figure 4).

**\*\*\*Insert tables 3 & 4 near here\*\*\***

**\*\*\*Insert figure 2 near here \*\*\***

**\*\*\*Insert figure 3 near here \*\*\***

**\*\*\*Insert figure 4 near here \*\*\***

## Discussion

In accordance with our hypothesis, the main finding from this study is that the performance scores of the HAT were reliable, valid and significantly associated with several athletic qualities of lower limbs related to handball. To the authors' knowledge, this is the first study to report reliability and validity of HAT for young handball players.

A significant correlation was reported between HAT and performance in two other agility tests (T-half test and Illinois test). The performances on the V5m and V10m test for acceleration and HAT test for COD agility were all correlated at high levels of statistical significance ( $p < 0.001$ ). These data would initially suggest that acceleration, jumping, and agility share common physiological and biomechanical determinants in young handball players. The small range of data observed within the sample of 24 subjects in the earlier research reduced the possibility of observing high correlations between the tests <sup>[18]</sup>. The greater sample size of 70 for the present study minimizes the chance that a low range of data will mask high correlations; therefore, the conclusion that acceleration, maximum speed, and agility are specific qualities in young players appears justified.

The initial sprint velocity and acceleration over the first few seconds of running are important for handball players, and the ability to accelerate over a single step could be a critical factor in some game situations <sup>[6]</sup>. The relationship between the V5m and V10m and the HAT has not been investigated previously. But, the existence of significant relationships is at first inspection somewhat surprising, since the two tests were intended to measure apparently differing abilities (velocities and muscle explosive force).

However, HAT test requires a sprint start with each change of direction, which could explain at least some of the observed relationship [6, 19].

Competitive handball requires frequent turning and changes of directions at a variety of intensities [5, 6] and this demands both muscular power and strength. The vertical jump performance of handball players varies with their competitive level [6] showing that this field test provides a useful measure of their ability. Again, scores on this test are significantly correlated with the HAT. We found a significant correlation between the HAT and vertical jump performance. We expected that these two measures would be related because of the similarities in the muscle contraction pattern (stretch shortening cycle); many other results in the scientific literature show moderately close relationships between agility tests and jumping performance [6, 7].

The significant relationship between HAT and the handball skill test is likewise somewhat no surprising, since the items purportedly measured are Skill vs. agility and speed. As in the sprint test, the skill test is essentially based on sprinting forward or backwards, with the subject exerting explosive force at each change of direction. In the slalom dribbling skill test used in this study, the player is instructed to adopt only a single pattern of movement (dribbling back and forth) in order to cover the distance as rapidly as possible. One possible factor contributing to the positive correlation between the HAT test and dribble test could be the acceleration and deceleration of the legs and changes of direction during the turns in HAT test. Possibly, this demands similar abilities to the dribbling test.

To the authors' knowledge, this is the first study to report reliability of the HAT. The information obtained from a substantial battery of field performance tests could be obtained more simply by having players undertake only the HAT test. Scores on this test accounted for 50-60% of the variance in the individual test measurements. If some of the existing tests were to be eliminated, this would allow coaches the opportunity to focus more on the assessment of other skills, such as throwing abilities. An obvious next step in this analysis will be to evaluate how well gains in the HAT can predict gains in individual test scores, as youth players undergo a rigorous training program. It will also be important to extend observations to players in other age groups (including females), and at other levels. It will also be of interest to correlate observations of this type with physiological estimates of anaerobic tolerance such as anaerobic

The results suggest that the HAT is a better measure of handball-specific capability than an equivalent nonspecific field test. HAT is also a valid and reliable field based assessment that could be used for talent identification and young handball player's selections. However, further studies should be carried out using players of different age, sex and ability and across greater test-retest durations to confirm these findings. While performance in a HAT with changes of direction is significantly related to a range of other athletic qualities. Further research should aim to determine the extent to which other qualities, including the ability to tolerate metabolic stress, influence linear repeated sprint ability.

## References

1. Young, WB., James, R., & Montgomery, I. (2002). Is muscle power related to running speed with changes of direction? **Journal of Sports Medicine and Physical Fitness**, 42:282–288.
2. Sheppard, JM., Young, WB., Doyle, TL., Sheppard, TA., & Newton, RU. (2006). An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. **Journal of Science and Medicine in Sport**, 9:342–349.
3. Zapartidis, I., Toganidis, T., Varelziz, I., Christodoulidis, T., Kororos, P., & Skoufas, D. (2009). Profile of young female handball players by position. **Serbian Journal of Sports Sciences**, 3: 53–60.
4. Mohamed, H., Vaeyens, R., Matthys, S., Multael, M., Lefevre, J., Lenoir, M., & Philippaerts, R. (2009). Anthropometric and performance measures for the development of a talent detection and identification model in youth handball. **Journal of Sports Sciences**. 27: 257–266.



5. Buchheit, M., Laursen, PB., Kuhnle, J., Ruch, D., Renaud, C., & Ahmaidi, S. (2009). Game-based training in young elite handball players. *International Journal of Sports Medicine*, 30: 251–258.
6. Hermassi S., Gabbett, TJ., Spencer, M., Khalifa, R., Chelly, MS., & Chamari, K. (2014) Relationship between explosive performance measurements of the lower limb and repeated shuttle-sprint ability in elite adolescent handball players. **International journal of Sports Science & Coaching**; V9: 5.
7. Chaouachi, A., Brughelli, M., Levin, G., Boudhina, NB., Cronin, J., & Chamari, K. (2009). Anthropometric, physiological and performance characteristics of elite team-handball players. **Journal of Sports Sciences**, 27: 151–157.
8. Farrow, D., Young, W., & Bruce, L. (2005). The development of a test of reactive agility for netball: a new methodology. **Journal of Science and Medicine in Sport**, 8:52–60.
9. Sekulic, D., Spasic, M., Mirkov, D., Cavar, M., Sattler, T. (2013). Gender-specific influences of balance, speed, and power on agility performance. **Journal of Strength & Conditioning Research**, 27(3):802-11.

10. Jakovljevic, ST., Karalejic, MS., Pajic, ZB., Macura, MM., & Erculj, FF. (2012). Speed and agility of 12- and 14-year-old elite male basketball players. **Journal of Strength & Conditioning Research**, 26(9):2453-9.
11. Munro, AG., & Herrington, LC. (2011). Between-session reliability of four hop tests and the agility T-test. **Journal of Strength & Conditioning Research**, 25(5):1470-7.
12. Gal, Ziv., & Ronnie, Lidor. (2009). Physical characteristics, physiological attributes, and on-court performances of handball players: A review Scandinavian, **Journal of Medicine & Science in Sports**, 9(6): 375-386.
13. Visnapuu, M., & Jürimäe, T. (2009). Relations of anthropometric parameters with scores on basic and specific motor tasks in young handball players. **Perceptual and motor skills**; 108(3):670-6.
14. Little, T., & Williams, AG. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. **Journal of Strength & Conditioning Research**, 19(1):76-8.
15. Sassi, RH., Dardouri, W., Yahmed, MH., Gmada, N., Mahfoudhi, ME., & Gharbi, Z. (2009). Relative and absolute reliability of a modified agility T-test and its relationship

with vertical jump and straight sprint. **Journal of Strength & Conditioning Research**, 23(6):1644-51.

16. Wilkinson, M., Leedale-Brown, D., & Winter, EM. (2009). Validity of a squash-specific test of change-of-direction speed. **International Journal of Sports Physiology and Performance**, 4(2):176-85.

17. Burgess DJ, Naughton GA. (2010). Talent development in adolescent team sports: a review. **International Journal of Sports Physiology and Performance**, 5: 103-116.

18. Hopkins, WG. (2000). Measures of reliability in sports medicine and science. **Sports Medicine**, 30:1-15.

19. Hermassi, S., Aouadi, R., Khalifa, R., van den Tillaar, R., Shephard, RJ., & Chelly, MS. (2014). Relationships between the Yo-Yo Intermittent Recovery Test and anaerobic performance tests in adolescent handball players. **Journal of Human Kinetics**, 44, 129-137.

Table 1. Performance characteristics and results of *absolute reliability* of HAT test ( $n = 70$ )

	Test trial 1(s)	Test trial 2 (s)	Mean difference	ICC (95% CI)	CV (%)
Subjects	7,50± 0,78	7,49 ± 0,74	0,01±0,28	0.92 (0.92–0.97)	2,7

Table 2. Intraclass correlation coefficients for relative reliability and coefficient of variation of the measured parameters ( $n = 70$ ).

	ICC	95%IC	CV (%)
T-half test (s)	0.91	0.82-0.96	3.9
Illinois agility test (s)	0.92	0.81-0.98	3.6
Squat jump (cm)	0.96	0.90-0.98	4.5
Countermovement jump (cm)	0.97	0.95-0.99	3.8
Sprints V5-m (s)	0.96	0.90-0.98	5.2
Sprints V10-m (s)	0.82	0.56-0.91	4.3
Handball skill test (s)	0.96	0.90-0.98	4.5

ICC = intraclass correlation coefficient; CI = confidence interval; CV = coefficient of variation

Table 3. Results of the measured parameters, values are given as mean  $\pm$  SD, ( $n = 70$ ).

	Mean	$\pm$ SD
Agility Tests		
T-half tests (s)	6.85	1.30
Illinois agility test (s)	8.28	1.03
Fitness of lower limb		
Countermovement jump (cm)	35.07	7.44
Squat jump (cm)	31.25	6.09
Sprints V5-m (s)	1.20	0.13
Sprints V10-m (s)	2.02	0.19
Handball specific skill test (s)	7.27	0.86

Table 4. Correlation coefficients obtained between HAT and the fitness measured parameters ( $n = 70$  for all relationships)

	Sprint V5- m	Sprint V10-m	CMJ	SJ	Handball skill test
New handball agility test	0.60**	0.55**	0.58**	0.38*	0.52**

\* $p < 0.05$ :

\*\* $p < 0.01$

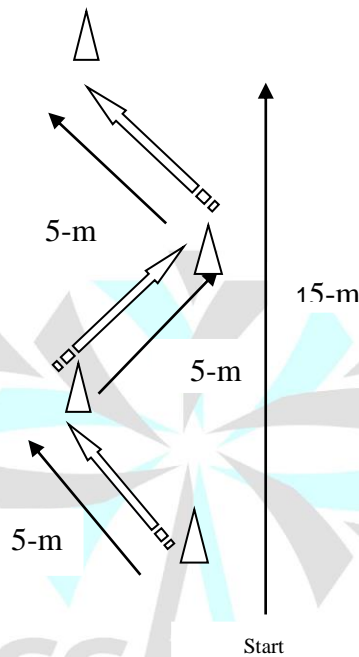
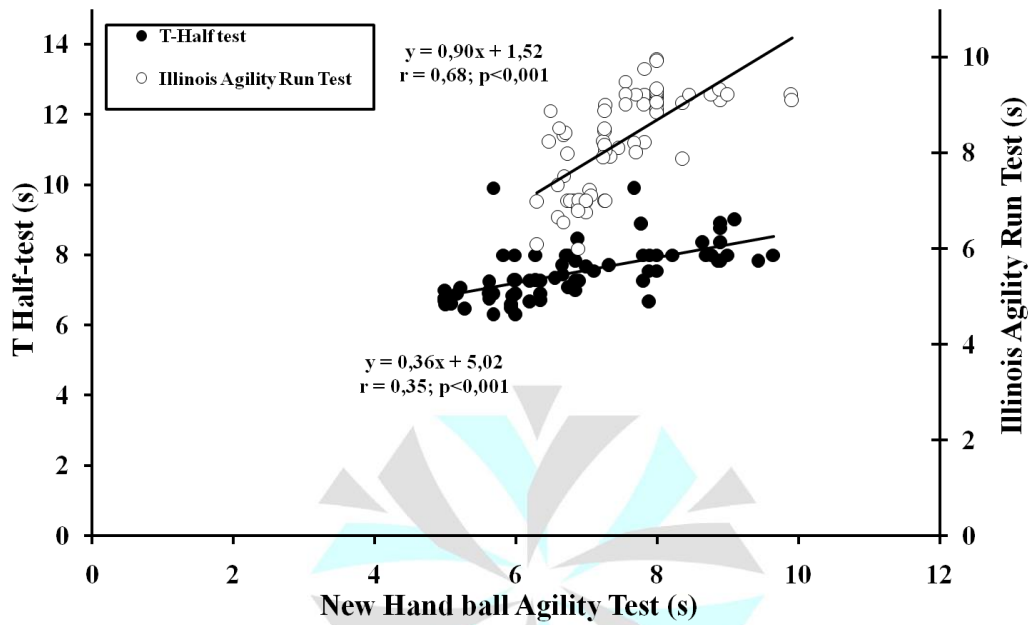
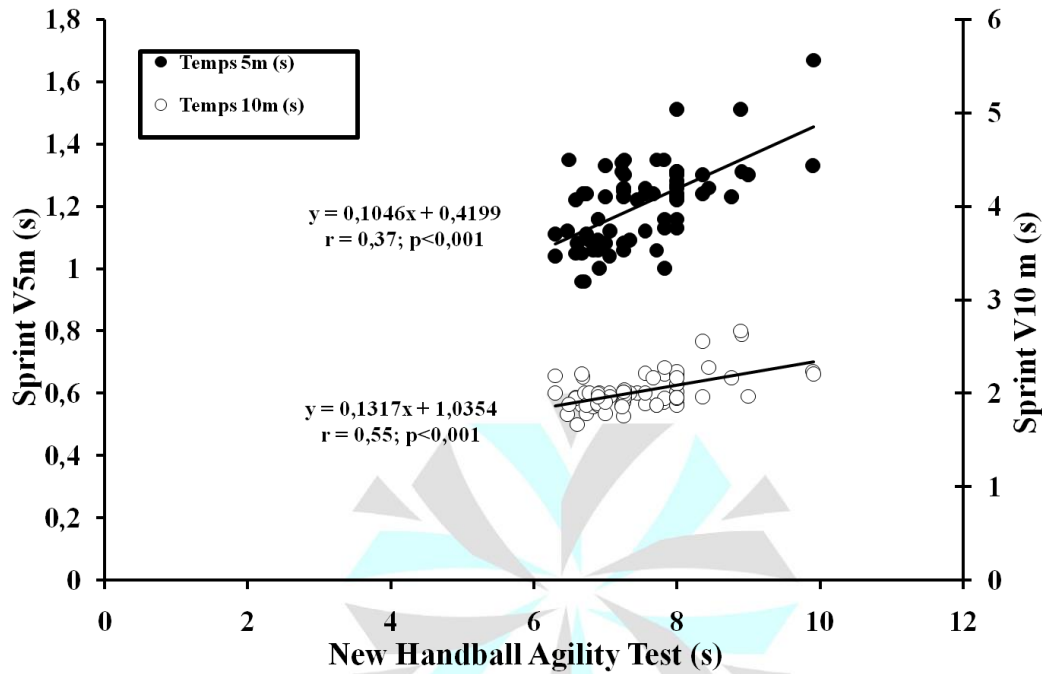


Figure 1. Diagram of the course used in the agility test. Each straight sprint is 5-m and each turn at a flag is  $100^\circ$ .



**Figure 2.** Relationship between the HAT, T-half test and agility Illinois run test

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**Figure 3.** Relationship between the HAT, sprint V5-m and V10-m performance

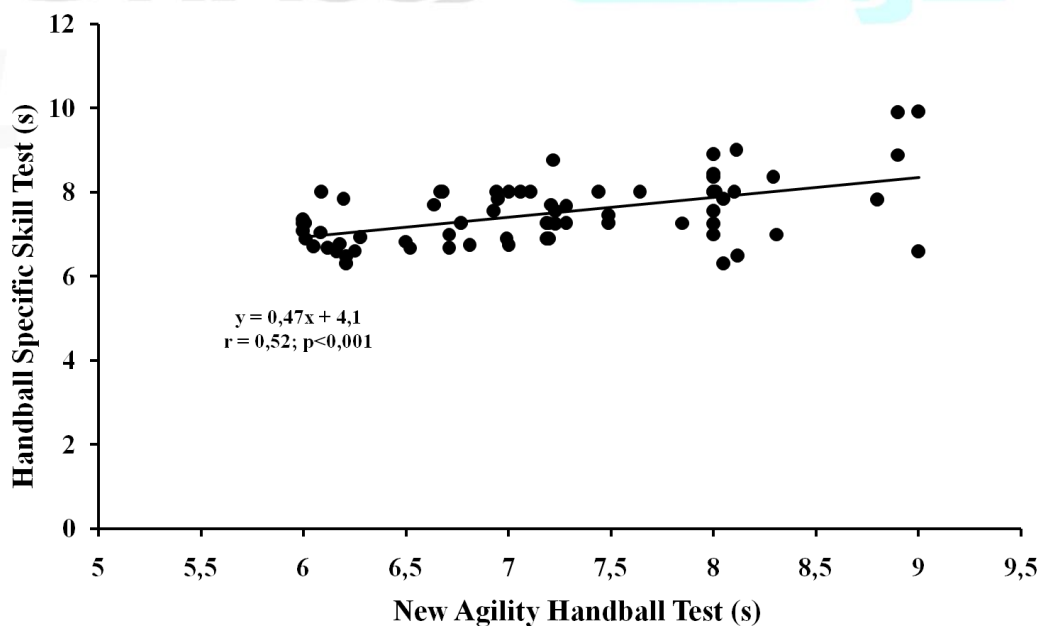




Figure 4. Relationship between the HAT and handball specific skill test.

