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Normative data of agility T-test as a measure of change of direction speed in children aged 10-11

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A B S T R A C T

The objective of the current study was to assess the relative agility T-test as a measure of change of direction speed and establish normative data specifically for children aged 10-11. A sample of 350 boys and 220 girls within the specified age range, with no medical history of disease, was randomly recruited from various schools. The mean and standard deviation, as well as the range of values, were determined for several variables including age, body mass, height, and BMI for both boys (n=350, age=10.83±0.38 years, body mass=34.42±5.61 kg, height=1.44±0.06 m, BMI=16.59±2.13 kg/m^2) and girls (n=220, age=10.79±0.41 years, body mass=34.85±6.36 kg, height=1.44±0.07 m, BMI=16.61±2.15 kg/m^2). The T-test, along with the FCMJ and 30mSS tests, were performed at least three times with a three-minute recovery period between trials and a five-minute recovery period between tests. Test-retest reliability of the T-test was evaluated using the intraclass correlation coefficient (ICC), which yielded values of 0.95 for girls and 0.97 for boys. Significant correlations were observed between the T-test and FCMJ as well as the 30mSS for girls (r=-0.384, p<0.0001 and r=0.416, p<0.0001, respectively) and for boys (r=-0.344, p<0.0001 and r=0.440, p<0.0001, respectively). The study provides percentile values that can be utilized to monitor the physical fitness levels of both girls and boys.

1. Introduction

In the basic movement pattern of many field and court sports such as football, handball, basketball, rugby, and racquet sports, players must accelerate, decelerate, and change direction throughout the play in response to stimulus, such as the movements of the opposing player or the movement of the ball (Sheppard and Young, 2006; Haj-Sassi et al., 2009). As a result, the player must change direction with minimal loss of speed, balance, and/or motor control (Fessi et al., 2016). These requirements are widely reported in the agility literature.

Agility is a complex physical ability that integrates several mechanisms and depends on many internal and external factors. It is an essential element in many sports, especially those that include complex movement patterns (Coh et al., 2018). Therefore, it is a quality of performance that contributes directly to the success of sports in which athletes must quickly change direction and speed (Sekulic et al., 2017). Similarly, Jeffreys (2006) indicated that agility is a key requirement for optimal performance in sports.

Agility is a determining quality in team sports that must be developed and evaluated by players. Thus, several studies have proposed different tests to measure it, such as the 505 (Draper and Lancaster, 1985; Gabbett et al., 2008; Lockie et al., 2015; Nimphius et al., 2016), the modified 505 (Gabbett et al., 2008), change of direction speed test

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(COST) (Sheppard et al., 2006), Y shaped planned (Green et al., 2011; Jeffriess et al., 2015; Lockie et al., 2014), the Shuttle Run (Harris et al., 2000; Sole et al., 2013), the Zigzag (Little and Williams, 2005), the Illinois Agility test (Lockie et al., 2013). Each of these tests varies in length, number, and angle of change of direction and patterns of movement. However, despite the validity of these tests, there are some limitations.

One of the main limitations associated with any change of direction tests is that they tend to have a relatively high number of linear sprints, which greatly affects the overall duration of the assessment (Nimphius et al., 2018). For example, the pro-agility shuttle (has a total of 18.28m of the linear sprint over approximately two 180° changes of direction) and the 505, traditional or modified version (Gabbett et al., 2008; Nimphius et al., 2016).

Second, some change of direction tests may be long enough (in time and distance) for anaerobic capacity to be a critical factor in performance (Nimphius et al., 2018). It is therefore unclear whether changes in performance are due to increased agility performance or improved anaerobic capacity. Not to mention the tests that neglect the mode of movement used in sports activities such as backward and lateral movements (Haj-Sassi et al., 2011).

On the other hand, the agility test, T-test is relatively simple to administer, as it requires a minimum of equipment and preparation. It is a tool for measuring four-way agility and body control that assesses the ability to quickly change direction while maintaining balance without losing speed (Pauole et al., 2000). However, we found that there is little data in the scientific literature concerning the normative values of physical evaluation tests in general and agility tests in particular. And to date, to our knowledge no published research has yet explored normative data for the T-test in children. This normative study would be useful for coaches in the initial selection of talented people for development programs, as well as to help coaches and sports scientists develop better training programs to improve agility performance. More specifically, normative databases can provide an approximate guide for coaches and sports educators to assess the physical abilities of their students or athletes.

The purpose of this study was to evaluate the relative agility T-test as a measure of change direction speed and to establish normative data of the T-test for children aged 10-11.

2. Methods

2.1. Subjects

The sample consisted of 350 boys and 220 girls aged 10 and 11 years old with no medical history of disease. Schoolchildren were randomly recruited from different towns in Tunisia. The mean±SD of age, height, body mass, and body mass index (BMI) are presented in Table 1.

2.2. Data collection

Demonstration of each test was given to children prior to testing and the first trial was considered as familiarisation. All measurements were conducted in random order and on a single day for each test subject by the same investigating team.

Body weight was measured to the nearest 0,1kg, using an electronic scale (Tanita BF679W Duo Scale). Height was measured to the nearest 5mm, using a tape measure attached to the wall. BMI was calculated as weight/height^2.

2.3. Physical fitness tests

All tests were performed indoors on a synthetic pitch at the sports university gymnasium. Before testing, subjects were allowed 15 minutes to complete individual warm-ups, including 3-5 minutes of light jogging, lateral displacements, dynamic stretching, and jumping. All subjects performed each test with 2 to 3 minutes of rest between all trials and 5 minutes between tests to ensure adequate recovery.

T-test and 30m straight sprint test (30mSS) performances were recorded to the nearest one-hundredth of a second using an electronic timing system (Globus, Microgate; SARL, Italy). Vertical jump performance (peak height) was measured by using the Opto-jump system (Microgate SARL, Italy).

2.3.1. T-test

The T-test (Fig. 1) was used to determine the speed with directional changes such as forward sprinting, left and right shuffling, and backpedaling. Based on the protocol outlined by Pauole et al. (2000), subjects began with both feet behind the starting line A. At their own discretion, each subject sprinted forward to cone B and touch the base of it with the right hand. Facing forward and without crossing their feet, they shuffled to the left to cone C and touch its base with the left hand. Subjects then shuffled to the right to cone D and touch its base with the right hand. They shuffled back to the left to cone B and touch its base. Subjects then ran back as quickly as possible past line A. The subject who crossed one foot in front of the other failed to touch the base of the cone and/or failed to face forward throughout, the test was repeated.

Each subject performed 3 test trials. Only the two last trials were used in the statistical analyses. The first trials were considered familiarization. The recorded score for this test was the better of the two last trials.

Table1: Physical characteristics of boys and girls

	Boys (n=350)	Girls (n=220)
Age (year)	10.83 ± 0.38	10.79 ± 0.41
Height (m)	1.44 ± 0.06	1.44 ± 0.07
Body mass (Kg)	34.42 ± 5.61	34.85 ± 6.36
BMI	16.59 ± 2.13	16.61 ± 2.15

Values are mean±SD

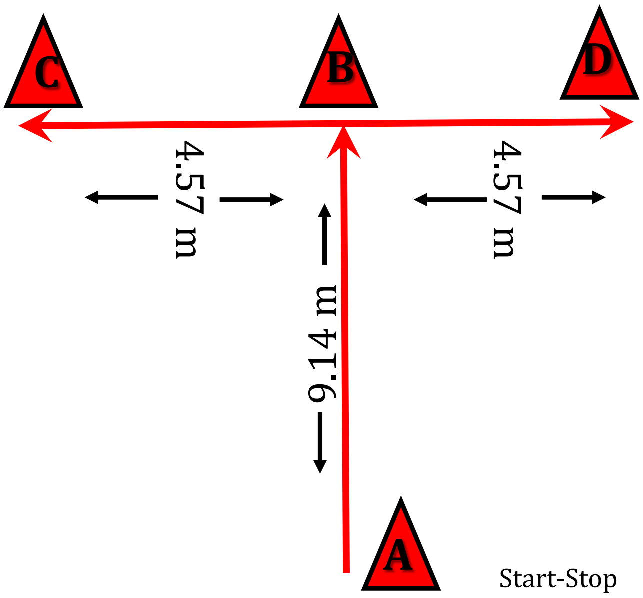

Fig. 1: Agility T-test; The athlete runs forward from cone A to cone B, then shuffles to the left (cone C), then shuffles to the right (cone D), then shuffles back to point B, before running backward to the start position (point A)

2.3.2. Straight sprint (30mSS)

Speed was evaluated using a straight sprint test, involving sprinting 30m as fast as possible from a stationary start position. The start commenced from a standing position. Subjects were instructed to begin with their preferred foot forward placed on a line marked on the floor.

2.3.3. Vertical jump

Jumping ability was assessed using a free countermovement vertical jump (FCMJ). Subjects were allowed to swing their arms freely but were not allowed any preparatory steps before jumping. The subjects performed three test trials. The recorded score for this test was the mean of the two last trials.

Statistical analysis: Data analysis was performed using the Statistical Package for Social Science (SPSS version 15 for Windows). Mean and SD values were calculated for each variable. The normality of appropriate data sets was checked using the Kolmogorov-Smirnov test. It was considered appropriate therefore to test stated hypotheses using parametric statistical techniques. The results were analyzed in the two groups separately. To determine relative reliability, the intraclass correlation coefficient (ICC) was calculated. A Pearson product-moment correlation was computed between the T-test and each of the other tests. The α level for all statistical tests was established at $p<0.05$. The elaboration of the normative data of the T-test by percentile from 10 to 90.

3. Results

Mean performance scores±SD at different tests for boys and girls are given in Table 2. Significant differences were found between boys and girls for T-test, FCMJ, and 30mSS.

Table 2: Mean performance scores±SD of T-test, FCMJ, and 30mSS for girls and boy

	T-test (s)	FCMJ (cm)	30mSS (s)
Girls (n=220)	13.49±0.79***	24.24±4.39	5.82±0.35***
Boys (n=350)	12.66±0.82	26.6±4.25***	5.56±0.29

*** Girls and boys performances are significantly different (p<0.001) from each other

Mean scores (SD) of the T-test for the first and the second test session, mean difference±SD diff., ICC values, for girls and boys are given in Table 3. There are no differences between test sessions scores in the two groups. ICC values to assess the relative reliability of the T-test were 0.92 (95% CI, 0.91-0.97) for girls and 0.95 (95% CI, 0.94-0.99) for boys.

Table 3: Performance characteristics and results of reliability of T-test for science sports students

	Test trial 1 Mean (SD) (s)	Test trial 2 Mean (SD) (s)	Mean difference (SD diff)	ICC (95% CI)
Girls (n = 220)	13.49 ± 0.79	13.46 ± 0.77	0.03 ± 0.19	0.95 (0.91-0.97)
Boys (n = 350)	12.66 ± 0.82	12.63 ± 0.81	0.03 ± 0.18	0.97 (0.94-0.99)

SD diff=standard deviation of the mean difference; ICC=Intra class coefficient; Values are mean±SD

Pearson product-moment correlation between all tests for both girls and boys was presented in Table 4. A low correlation was found between T-test and FCMJ, MAT, and 30mSS tests in girls, and it was not significantly correlated with these tests in boys.

Table 4: Pearson product-moment correlation (95% CI) between the T-test, FCMJ, and 30mSS girls and boys

T-test	FCMJ	30mSS
Girls (n=220)	r=- 0.384** (-0.437 – -0.283)	r=0.416* (0.312 – 0.509)
Boys (n=350)	r = 0.344 (-0.424 – -0.258)	r = 0.440 (0.358 – 0.516)

95% CI=95% confidence interval; ** Correlation is significant at the 0.01level (2-tailled); * Correlation is significant at the 0.05 level (2-tailled)

Table 5 reports the Percentile values of T-test performance in children, classified by sex and age and expressed as percentiles from 10 to 90. The results in Table 5 showed an increase in T-test performance with age. The boys obtained strictly higher T-test scores than the girls.

Table 5: Percentile values of girls and boys specific for the T-test

	M	SD	P10	P20	P30	P40	P50	P60	P70	P80	P90
					Girls						
10 year	13.19	±0.55	12.47	12.63	12.94	13.05	13.23	13.38	13.49	13.59	14.1
11 year	12.45	±0.30	12.00	12.22	12.35	12.41	12.52	12.59	12.65	12.69	12.79
					Boys						
10 year	12.51	±0.92	11.43	12.00	12.19	12.26	12.46	12.62	12.80	13.05	13.4
11 year	11.60	±0.42	11.12	11.35	11.44	11.52	11.67	11.71	11.89	12.02	12.05

4. Discussion

The main finding of this study showed that the reliability of the T-test in children 10-11 years was found to be high across the two measurement trials. Most recent researchers (Hopkins et al., 2001; Pearson et al., 2006; Aziz and Chuan, 2004; Haj-Sassi et al., 2009) investigated the reliability of field testing and have used the ICC values. They considered these two methods as the most appropriate and objective to assess reliability. ICC across the two trials in our study was 0.95 and 0.97 for girls and boys, respectively. These values were comparable to the relative reliability of other agility tests. Pauole et al. (2000) reported an ICC of 0.98 across three agility T-test trials in college-aged men and women. Sheppard et al., 2006 found an ICC of 0.87 across two reactive agility test trials in thirty-eight Australian football players. Morral-Yepes et al. (2022) reliability showed a high ICC in almost all studies (0.79-0.99). As a general rule, an ICC over 0.90 is considered high, between 0.80-0.90, moderate, and below 0.80 to be insufficient for physiological field tests (Thomas and Nelson, 2001). Similarly, Gharbi et al. (2012) reported an ICC of the Modified T-test greater than 0.90 in young footballers. Thus, our results demonstrated high reliability. The test-retest ICC in our data is high despite the fact that statistical analyses were assessed separately in girls and boys.

To determine the criterion validity of the T-test as a measure of direction change speed, we investigated its relationship with the vertical relaxation test (FCMJ), and the 30m straight-line sprint tests, because the power of the legs and the speed are two necessary and determining factors for agility.

The reproducibility of the different tests used to verify the validity of the T-test criterion was very satisfactory.

During this study, we found a significant correlation between T-test and FCMJ and 30mSS for girls (r=-0,384, p<0,0001 and r=0,416, p<0,0001respectively). Significant correlations were found between T-test and FCMJ and 30mSS for boys (r=-0,344, p<0,0001 and r=0,440, p<0,0001 respectively). The results of the present study agree with the studies of Pauole et al. (2000), Peterson et al. (2006), Haj-Sassi et al. (2009), and Gharbi et al. (2012). Indeed, Pauole et al. (2000) reported low to moderately significant correlations between the shifting t-test and a 40-yard (36.58-meter) sprint (r=0.73 for women and r=0.55 for men) and a vertical jump (r=-0.55 for women and r=-0.49 for men). Similarly, Peterson et al. (2006) reported a significant correlation between the T-test and the vertical jump (CMJ) in women but not in men. They also reported a weak correlation between the T test and acceleration (20 yards with a 40-yard split) and sprinting (40 yards). Additionally, Haj-Sassi et al. (2009) found significant correlations between the modified T-test and FCMJ, and MAT and 10mSS in women (r=20.47, p<0.01 and r=0.34, p<0.05).

In response to the lack of reference values for agility tests in children, the objective of this study was to develop T-test reference values for children aged 10 and 11 years.

We have already verified the reproducibility and validity of this test for this population.

The values of this study are presented in percentiles from 10 to 90 and classified according to age for boys and girls.

Like the results of the present study, other works have provided reference values for physical fitness tests, for example for the Wingate test, the repeated Sprint test (2×5×20m), Test (Y-balance test), and battery test (Ramírez-Vélez et al., 2016; Selmi et al., 2016; Johnston et al., 2019; Weston et al., 2019). Indeed, Selmi et al. (2016) established normative data for the RSS test based on the state of maturity in two hundred and sixty-two young footballers aged 11 to 18.

Note only Pauole et al. (2000) and Gabbett and Georgieff (2007) as well as Koulouvaris et al. (2018) have developed normative data for the T-test.

Our results show that the best performances found in 10-year-old children are 12.47 s and 11.43 s for girls and boys respectively. Also, in children, 11 years are 12s and 11.12s for girls and boys respectively. These values are comparable with the study by Koulouvaris et al. (2018). In this study, the best performances of children aged 9-10 years are 13.56 s and 12.78 s for girls and boys respectively. Also in children aged 11-12 years are 12.28 and 11.7 s for girls and boys respectively. These values are very close to those obtained in our study. Similarly, Pauole et al. (2000) showed that the best performances obtained during the T-test are 10.69 s and 9.45 s respectively in women and men aged 22 years. These performances are superior to that of our study because of the difference in the age of the subjects (Adults vs young people).

5. Conclusions

The study provides T-test a with good relative reliability for girls and boys aged 10 and 11. The T-test was not strongly correlated with short straight sprints and vertical jumps. Percentile values showed that boys are more agile than girls at ages 10 and 11. The percentile values are useful to monitor the physical fitness status of girls and boys and help coaches to detect and select young sports talents. Future research could investigate other factors that will contribute considerably to the change of direction speed performance.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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