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Original Article

Verification of speed and agility K-test in junior football players

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Abstract:
The aims of the study were to determine validity of the K-test and to determine reliability, usefulness, and responsiveness. The research study involved a total of 98 football players in the U17 and U19 categories from Czech Republic (men; age 16.9 ± 1.3 years, height = 177.1 ± 4.6 cm, weight = 68.7 ± 4.6 kg). The speed and agility K-test was applied. The time was measured by electronic timing gates. The high intraclass correlation coefficient value (ICC = 0.89; 90% CI: [0.83, 0.93]) implies a very high level of intra-rater reliability. The value only 0.10 s (0.092-0.13 s) for standard error of measurement was found and therefore the coefficient of variation was 0.93 % (0.85 - 0.95 %). The smallest worthwhile change was 0.29, thus 2.68 %. The results of t test (t0=0.24) comparing third and fourth (after intervention) ratified null hypothesis about size of intervention effect to K-test results, and smallest worthwhile change was 0.02. This study showed empirical support to the construct validity of K-test as indicators of match-related physical performance in top level professional football players. We consider K-test to be practical, specific, reliable, valid, and useful test to evaluate agility performance of football players.
Keywords: agility, speed, reliability, validity, football

Introduction

Soccer is a very popular team sport with nearly 200 million players worldwide (Dupont, Blondel, Lensel & Berthoin, 2002). It contains positive motivational and social factors that may facilitate compliance and persistence with sport and contribute to the maintenance of a physically active lifestyle (Mohr, Krustrup & Bangsbo, 2003).

Match analyses of player's match performance showed that soccer is sport of acyclic nature and intensity, it is classified as a high intensity intermittent sport (Bangsbo, Mohr & Krustrup, 2006; McMillan, Helgerud, Macdonald & Hoff, 2005). Average distance covered is 10-12 km (Stølen, Chamari, Castagna & Wisloff, 2005). The most important component of football performance is considered to be speed and explosive power (Reilly, Bangsbo & Franks, 2000) which support the agility. Elite players perform approximately 30 – 40 sprints during a match and more than 700 turns (Bloomfield, Polman & O'Donoghue, 2007). Mean sprint duration is between 2 and 4 s, and the vast majority of sprint displacements are shorter than 20 m (Haugen, Tonnessen, Hisdal & Seiler, 2014).

Every measure to be practically useful should be reliable, valid, and responsive (Husted, Cook, Farewell & Gladman, 2000). The validity of most currently used football tests is based predominantly on their intrinsic characteristics (logical validity) (Impellizzeri et al., 2008). In addition, the construct validity is determined as a comparison of match performance with test results (Impellizzeri, Rampinini & Marcora, 2005). Another work observed differences of test results and various playing position to determine validity of the test (Krustrup et al., 2003).

Reliability is a theoretical concept that is used to describe the quality of a measurement instrument (Hulka, Cuberek & Svoboda, 2014). Researchers and practitioners require evidence of reliability (and validity) to justify measurement approaches that are used for surveillance, screening, training evaluation, and training workouts. The knowledge of various sources of measurement errors helps individuals to better understand the collected data and the overall analysed phenomenon (Hůlka, Weisser, Bělka & Háp, 2015). These characters of the test should be completed with the ability of a measure to change over a particular pre-specified time frame. This character is represented by the responsiveness (Impellizzeri & Marcora, 2009). The latter is also called sensitivity to change and refers to the ability of a measure to change over a particular time frame (Impellizzeri & Marcora, 2009). Conditioning tests should be evaluated for their usefulness in identifying real improvements in performance. To increase the relevance of a field test, usefulness should be calculated (Gonzalo-Skok, Tous-Fajardo, Luis Arjol-Serrano & Mendez-Villanueva, 2014). This quality we consider to be pointer of real increase or decrease of the performance, or quality expressed change caused by error of measurement. We did not find the study, which showed these characters for K-test. And that is why the aims of the study were 1) to determine validity of the K-test and 2) reliability, usefulness, and responsiveness.

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Materials and Methods

The research study involved a total of 98 football players in the U17 and U19 categories from Czech Republic (men; age 16.9 ± 1.3 years, height = 177.1 ± 4.6 cm, weight = 68.7 ± 4.6 kg). Forty nine players played the division (third highest) and forty nine players were involved in the highest nationwide league (called the 1st league) in the 2016/2017 season and had at least eight years' experience of the game. The goalkeepers were not included. Players from highest league took part in four team sessions (6 hours per week), one conditioning session (one hour per week), and one individual training session per week (one hour per week). They completed whole four measurement sessions for reliability and validity measurement needs. Players from third league took part in three team sessions (4.5 hours per week) and one conditioning session (one hour per week). They completed one trial session and one official session for validity measurement needs. The study was approved by local ethic committee. Prior to data collection the players were informed about the purpose of the measurements and provided written, informed consent in accordance with the Helsinki Declaration. The involvement of the players was voluntary and the results were used only for the purposes of this research.

The speed and agility K-test was applied. Every player completed three attempts with 10 min recovery. The best time was taken. The scheme of K-test is shown on Figure 1. The distance between cones 1-2 and 1-5 was 4.5 m. The distance between cones 2-3 and 5-4 was 3 m. The time was measured by electronic timing gates (PR1aW, Alge-Timing GmbH, Austria) with one hundredth of a second accuracy.

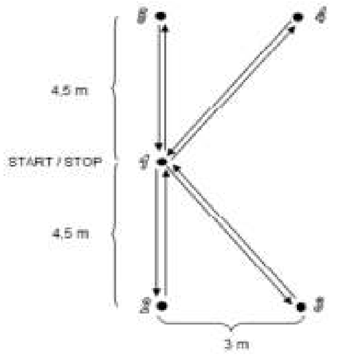

Figure 1. Scheme of K-test.

The measurement run during six-week pre-season preparatory phase of season on July and August 2016. Whole measurement was performed on the grass pitch. To find out reliability, first three measurements were realized one week before starting training program on Monday, Wednesday and Friday, always at the same time. Last measurement was performed on the end of six-week pre-season preparatory phase on Monday. Twenty minutes dynamic warm up was applied before every measurement.

For statistical data processing we used the SPSS statistical software (17.0 version; SPSS Inc., Chicago, IL). Data were expressed as means (*M*) ± standard deviation (*SD*). The prerequisites of normality and homogeneity of variance were verified using the Shapiro-Wilks and Lilliefors tests, respectively. To detect a systematic bias, one-way ANOVA was used on three repeated assessments. The construct validity was verified per two-way ANOVA (2x4 design) (Impellizzeri et al., 2008). The independent variables included a between-subject factor "competitive level" with two levels (top-professional and amateur), and a between-subject factor "playing position" with three levels (defender, midfielder, and forward). The Bonferroni post hoc test was applied. To determine relative reliability intraclass correlation coefficient was calculated using the formula $ICC = (MSS - MSE) \cdot MS^{-1}$, where *MSS* is the mean square of the subjects, *MSE* is the mean square of the error, and *MS* is the mean square) (Hopkins, 2000). Absolute reliability was expressed by Standard error of measurement (SEM) as $SEM = SD \cdot \sqrt{(1-ICC)}$, where *SD* is the standard deviation of the sample and *ICC* is the calculated intraclass correlation coefficient (the unbiased error) (Atkinson & Nevill, 1998) and expressed by percent as a coefficient of variation (CV). The usefulness was expressed by comparing the smallest worthwhile change (SWC) as $SWC=1.96 \times TE \times \sqrt{2}$ with SEM (Mann, Ivey, Mayhew, Schumacher & Brechue, 2016). We consider the test to be OK when SEM<SWC (Hopkins, 2000). To determine responsiveness paired t-test was calculate, a value of t_0 greater than 1.96 indicates that the data provide evidence to reject the null hypothesis (Husted et al., 2000), and standardized response mean (SRM) as effect size $ES=t_0/\sqrt{n}$, when *n* was number of participants. The statistical significances of all parts of the analysis were determined at an alpha level of 0.05.

Results

The players achieved 11.05±0.42 s during first trial, 10.95±0.43 s during second trial, 10.99±0.43 s during third trial, and 10.78±0.33 s after six-week pre-season preparatory phase of season in fourth trial. When we divided the data according to competitive level, we detected 12.05±0.49 s for amateur players and 10.98±0.35 for top players. The dismemberment according to playing positions we obtained 11.68±0.63 s for defenders, 11.36±0.70 s for midfielders, and 11.40±0.69 s for forwards (Table 1.).

According to the one-way ANOVA findings, there were no statistically significant differences (F = 1.47; p = 0.23) between the results obtained from the first, second and third measurements. The high intraclass correlation coefficient value (ICC = 0.89; 90% CI: [0.83, 0.93]) implies a very high level of intra-rater reliability. The value only 0.10 s (0.092-0.13 s) for SEM was found and therefore the CV was 0.93 % (0.85 - 0.95 %). The smallest worthwhile change was 0.29, thus 2.68 %. The results of t test (t_0=0.24) comparing third and fourth (after intervention) ratified null hypothesis about size of intervention effect to K-test results, and SRM was 0.02. The construct validity was verified by two-way ANOVA (table 1).

Table 1. The results of validity study.

	K-tets (s) M±SD	Main factor
Competetive level		F=33.49; p=0.001
Amateur (n=49)	12.05±0.49	
Top (n=49)	10.98±0.35	
Playing positions		F=0.31; p=0.81
Defenders (n=38)	11.68±0.63	
Midfielders (n=42)	11.36±0.70	
Forwards (n=18)	11.40±0.69	
Competetive level vs. Playing positions		F=0.10; p=0.96

Discussion

Reliability is a theoretical concept that is used to describe the quality of a measurement instrument. Researchers and practitioners require evidence of reliability (and validity) to justify measurement approaches that are used for surveillance, screening, training evaluation, and training workouts. The knowledge of various sources of measurement errors helps individuals to better understand the collected data and the overall analysed phenomenon (Hulka et al., 2014). The aims of the study were 1) to determine validity of the K-test and 2) to determine reliability, usefulness, and responsiveness.

The results achieved by participants in this study were similar to work of Lee, Zahalka, Maly and Mala (2017), who found out 11.14.±0.26 with U17. This work showed worse results than Maly, Zahalka, Mala and Teplan (2014), who achieved 10.65 ± 0.37 s.

The results showed that application of K-test on soccer players is affected by systematic bias only minimally (F = 1.47; p = 0.23). Due to simplicity of the test scheme, the source of errors resulting from learning effect was eliminated.

The soccer performance is based on short sprint bursts occurs approximately every 90 seconds each lasting an average of 2-4 seconds (Stølen et al., 2005). More over the activities executed by maximal intensity can be categorized into actions requiring acceleration, maximal speed, or agility (Little & Williams, 2005), these activities are considered to be crucial for soccer performance (Paul, Gabbett & Nassis, 2016). Above that, the results of analysis of variance (table I.), which compared K-test results of amateur and top players showed the difference, showed significantly lower performance at amateur compared to professional players. The ability to discriminate between players of different competitive levels and playing position further support the construct validity of this test (Impellizeri et al., 2008).

Absolute reliability analysis would indicate the consistency with which players are able to repeat a performance on a given test over time (Hopkins, 2000; Hopkins, Hawley & Burke, 1999; Mann et al., 2016). Relative reliability would provide the consistency with which players maintain their ranking within a group when performing a specific test (Hopkins, 2000; Mann et al., 2016). The value of SEM was found 0.10 s (0.092-0.13 s). It represents coefficient of variation of 0.93 %. The absolute consistency analysis showed high level of inter-individual stability of results, because the values of CV were recommended to be lower than 5 % (Buchheit, Lefebvre, Laursen & Ahmaidi, 2011) or 3 % (Hopkins et al., 1999). The absolute reliability is high in comparison with similar studies too (Oliver & Meyers, 2009).

The relative consistency, expressed by intraclass correlation coefficient (ICC = 0.89; 90% CI: [0.83, 0.93]) showed high level of consistency. It exceeded value of 0.80 which is considered as for physical and physiological tests [28]. The results were similar to other studies, when [29] showed 0.81 to 0.88 agility test for team sports (Green, Blake & Caulfield, 2011; Spiteri, Nimphius, Hart, Specos, Sheppard & Newton, 2014). One of the highest values calculated 0.98 for total time of T-test in handball and rugby (Fessi et al., 2016).

With regard to high level of reliability, the usefulness should be established before its application in the training or next research. The SEM can be used to define the difference needed between separate measures on a subject for the difference in the measures to be considered real (Weir, 2005). Former studies recommended to extend the reliability research by comparing the smallest worthwhile change (SWC) with SEM, thus to determine the

usefulness (Impellizzeri et al., 2009). According to Gozalo-Skok et al. (2014) our results SEM was lower than SWC (0.10 < 0.29), the test was rated as good.
To determine responsiveness paired t-test was calculate, a value of t_0 greater than 1.96 indicates that the data provide evidence to reject the null hypothesis. The paired t -test statistic has been used to analyse data originating from a one-group repeated measures design (Husted et al., 2000). Our results showed low responsiveness to six-week training intervention (t_0=0.24). when calculating effect size expressed by SWC=0.02, only small responsiveness of the test. It would be interesting to intend on the effect size of speed test due to ambitiousness of speed development as genetically limited ability.

Conclusions

This study showed empirical support to the construct validity of K-test as indicators of match-related physical performance in top level professional football players. We consider K-test to be practical, specific, reliable, valid, and useful test to evaluate agility performance of football players. The problem of K-test application we behold in small responsiveness of test, that is why the coaches and researchers should be prudent during interpretation of the results. Further research with players of age, gender, and playing standards should be follow before the applicability of the current results can be generalized.

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