Original Article

Differences in the performance tests of the fast and slow stretch and shortening cycle among professional, amateur and elite youth soccer players

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ABSTRACT

Keiner, M., Sander, A., Wirth, K., & Hartmann, H. (2015). Differences in the performance tests of the fast and slow stretch and shortening cycle among professional, amateur and elite youth soccer players. *J. Hum. Sport Exerc., 10*(2), pp.563-570. The purpose of this study was to establish whether physical attributes can differentiate between professional, amateur and elite youth soccer players; such a distinction could aid in the selection process for youth soccer. Therefore, this investigation evaluated a suspected difference in the performance tests of the slow and fast stretch and the shortening cycle (squat jump [SJ], counter-movement jump [CMJ], and drop jump from varying heights [DJ]) among professional, amateur and elite youth soccer players. Cross-sectional data were collected. The results indicate that higher performance in the SJ and CMJ seem to depend on the level of player because the mean performance of the PRO was 38.7 ± 4.0 cm in the SJ and 41.2 ± 3.8 in the CMJ, which were significantly ($p<0.05$) different compared with all other groups. In the DJ, there were significant ($p<0.05$) differences between the professional players (PRO) and lower-level players as well as between the PRO and youth soccer players. The results suggest that jump performance can differentiate between elite, sub-elite, and youth soccer players and highlights the importance of appropriate conditioning for developing strength and power in youth soccer players. **Key words**: SPEED-STRENGTH, LEVEL OF PLAY, SOCCER PLAYERS, TALENT IDENTIFICATION.

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Submitted for publication November 2014
Accepted for publication May 2015
JOURNAL OF HUMAN SPORT & EXERCISEISSN 1988-5202

doi:10.14198/jhse.2015.102.03

INTRODUCTION

The requirement profile for team sports is very complex. In addition to technical and tactical requirements, there are conditional requirements. These conditional requirements are the basis for technical and tactical tasks. The conditional requirements in team sports are also complex. Stølen, Chamari, Castagna, & Wisløff (2005) reported that there are 1,000 to 1,400 power actions, such as jumps, sprints and changes of direction, in a soccer game. At first, the percentage of sprinting in relation to the covered distance seems to be low. However, a detailed analysis shows that the speed strength actions are important for winning the game (Reilly, 2007; Verheijen, 1998). Speed strength seems to determine performance in soccer. With this in mind, higher level soccer players should perform better than lower level soccer players in tests of slow and fast stretch and shortening cycle (SSC). For example, Gall, Carling, Williams, & Reilly (2010) found differences in performance between international, professional and amateur youth soccer players for the linear sprint and countermovement jump (CMJ) with arm swing. In soccer, there also appears to be a difference between elite youth soccer players and professional players in performance tests for slow and fast SSC. Many researchers have reported significant differences in performance in jump performance (Chan, Lee, Fong, Yung, & Chan, 2011; Dowson, Nevill, Lakomy, Nevill, & Hazeldine, 2002; Dunbar & Power, 1997; Hoshikawa, Campeiz, Shibukawa, Chuman, Iida, Muramatsu, & Nakajima, 2009; Lehance, Binet, Bury, & Croisier, 2009). This performance difference between elite, sub-elite, and youth soccer players seems to also be true for sprint performance (Chan et al., 2011; Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001), but professionals do not always perform statistically better in sprints (Cometti et al., 2001). These results in soccer are in line with other team sports. Gabbett, Jenkins, & Abernethy, (2010), Gabbett, Kelly, & Sheppard, (2008) showed a difference between professional and amateur players in performance tests for other team sports (see also, Baker & Newton, 2008).

Therefore, increasing the speed-strength performance of an athlete should facilitate entry into higher divisions, which should help elite youth players transition into the professional sport. The topic of this investigation is to evaluate a suspected difference in the performance of the slow and fast SSC of professional, semi-professional, amateur and elite youth soccer players. These results may identify key performance tests that are associated with a higher level of soccer performance that could aid in the selection process for elite soccer. It was hypothesised that elite players would have superior jump performances compared to amateur level and youth players due to their higher level of sporting performance.

MATERIAL AND METHODS

The objectives of this study were to evaluate a possible difference in performance tests of the slow and fast stretch and shortening cycle (squat jump [SJ], counter-movement jump [CMJ], and drop jump from varying heights [DJ]) among professional, semi-professional, amateur and elite youth soccer players (n=163). To accomplish these objectives, the performance of professional, semi-professional, amateur and youth soccer players was measured and compared. The SJ, CMJ, and DJ were designated as dependent variables. The playing level (youth elite soccer player [YS], professional [PRO], semi- professional [SEMI] and amateur [AMAT]) was designated as the independent variable. The investigators followed the ethical guidelines for research with human participants. The investigators informed all participants of the research objectives and all aspects of the research. All participants provided written informed consent prior to participation. Informed consent was obtained from the subjects' parents, and when participants were aged 18 years and older, the consent was obtained from the subjects themselves.

Participants

The participants were divided into 5 groups. Group 1 consisted of professional players in the first and second division in Germany (PRO). Group 2 consisted of amateur players in the second highest amateur division in Germany (Hessenliga, 5th League in Germany, State League; SEMI). Groups 3 and 4 consisted of youth elite soccer players in a U19 (under 19 years old) team and U17 team at the youth training centre of a professional team. The 5th group included amateur soccer (AMAT) players from the 3rd lowest soccer league in Germany. The anthropometric data are reported in Table 1. The PRO players trained 1.5 to 2 hours 5 to 6 times per week, and the AMAT and youth soccer players trained 1.5 hours 4 times per week. The AMAT trained 1.5 hours 2 times per week. None of the players in the study participated in regular, periodised strength training.

Table 1. Anthropometric data

Group	N	Age (a)	Weight (cm)	Height (kg)
Professional player	50	26.1 ± 3.7	77.7 ± 6.5	183.8 ± 6.9
Semi-professional player	20	22.1 ± 1.9	67.3 ± 3.5	177.9 ± 3.6
Amateur players	21	24.1 ± 3.7	74.1 ± 4.7	179.2 ± 3.6
Under 19 years old	39	18.4 ± 0.5	72.8 ± 7.2	177.9 ± 5.9
Under 17 years old	33	16.7 ± 0.2	71.3 ± 7.6	179.3 ± 6.1

Measures

Squat Jump (SJ): The SJ is a vertical jump from the crouch position without momentum (test-retest correlation $r=0.87$, $p<0.01$). The knees bend in a 90° position, the body is upright and the hands remain fixed to the hips.

Counter-Movement Jump (CMJ): The CMJ is a vertical jump with momentum (test-retest correlation $r=0.94$, $p<0.01$). The jump is initiated from an upright position, and the centre of the body is lowered until the knees are bent at a 90-degree angle. Then, the extension of the hip and knees begins.

Drop Jump (DJ; test-retest correlation $r=0.85–0.88$, $p<0.01$): The DJ was performed from different heights (24 cm [DJ24], 32 cm [DJ32], 40 cm [DJ40]). The participants fall from a box to the ground after initiating a step forward. When both feet contact the ground, the participant jumps as high as possible. The reactive power of the participant is improved for a shorter duration of ground contact (ms) and a higher jump (cm). From these data, a performance index (LI) was calculated (LI = jump height in millimetres / contact time in milliseconds x 100).

Procedures

The players underwent a 10-minute standardised warm-up. The warm-up programme consisted of a submaximal run, and run-ABC exercises were performed for approximately five minutes. Run-ABC exercises included the knee-lift run, heeling, and the side step. Next, they completed a three-minute dynamic stretching programme for the lower extremities, and then, they completed three 50-metre increase runs with short intervening walking breaks. After the warm-up, all participants completed the series of tests, in the displayed order.

Every participant performed up to three test trials for each jump. Then, five test jumps were completed. A contact mat was used to evaluate the variables. The soccer players performed the testing protocol during June 2012, which was 2-3 weeks after the last match of the season. None of the subjects participated in a fatiguing training session for a minimum of 2 days before testing. None of the participants reported any injury at the time of testing. All participants were familiarised with the tests by performing a pretest 1 week before testing. Anthropometric and performance measurements were collected by the same researchers at the same time on the testing day, and all participants were asked to wear the same clothing and footwear.

Analysis
The data were analysed with the Kolmogorov-Smirnov test for a normal distribution and the Levene test for variance homogeneity. The data were then analysed using analyses of variance. If necessary, the variance was corrected and a Bonferroni correction for p-values was applied. The significance level was set at $p \leq 0.05$ for both tests. The effect sizes were then calculated for each variable [$d = (M1 - M2 / \sqrt{((SD1^2 \times SD2^2) / 2)}$]. In general, effect sizes greater than 0.5 are interpreted as large, those ranging from 0.5 to 0.3 are considered to be moderate, those ranging from 0.3 to 0.1 are considered to be small, and those less than 0.1 are considered to be negligible.

RESULTS

All data were normally distributed, and the test for variance showed homogeneity of the variance. The descriptive data are displayed in Table 2. The analyses of variance were calculated for the SJ significant F-values (F=12.3; p=0.000), CMJ significant F-values (F=6.7, p=0.000) and DJ significant F-values (DJ24: F=7.6; p=0.000; DJ32: F=6.8, p=0.000; DJ40=7.5, p=0.000). The pairwise comparisons of the groups showed significant (p<0.05) differences for some groups in the performance, and these differences are marked in Table 2.

Table 2. Group differences of the speed-strength parameters

Group/variables	SJ	CMJ	DJ24	DJ32	DJ40
U17	33.7 ± 3.4P	35.1 ± 3.7P	172 ± 26P	177 ± 25P	169 ± 28P
U19	33.3 ± 3.4P	37.4 ± 3.5 P	189 ± 34A	198 ± 47	196 ± 45A
AMAT	34.6 ± 4.7P	37.6 ± 5.6p	157 ± 48P,U19	168 ± 57 P	162 ± 60 P, U19
SEMI	34.7 ± 4.6P	39.1 ± 3.7P	187 ± 23	186 ± 32	191 ± 30
PRO	38.7 ± 4.0*	41.2 ± 3.8*	203 ± 32U17, A	213 ± 33U17, A	210 ± 34U17, A

P=significantly (p<0.05) different compared to PRO; A=significantly (p<0.05) different compared to AMAT; U19=significantly (p<0.05) different compared to U19; U17=significantly (p<0.05) different compared to U17; * significantly different compared to all other groups.

The effect sizes for the significant (p<0.05) differences in the SJ of the PRO compared to the other groups were calculated between d=0.6 to d=1.0 and were between d=0.4 to d=1.2 for the CMJ. The effect sizes for the significant (p<0.05) differences in the DJ24, 32, and 40 of the PRO compared to the U17 and AMAT were calculated between d=0.7 to d=0.9. The effect sizes for the significant (p<0.05) differences in the DJ 24, 32, and 40 of the U19 compared to the AMAT were calculated between d=0.4 to d=0.5.

DISCUSION

The data collected in this study provide some interesting clues to the differences in the performance levels in the speed-strength tests of soccer players and young players in different performance classes. These data are consistent with the data in the literature (Ronnestad, Kvamme, Sunde, & Raastad 2008; Silva, Magalha, Ascensa, Oliveira, Seabra, & Rebelo, 2001; Wong & Wong, 2009). The data for the SJ and CMJ groups show suspected differences among the performance categories, which is in agreement with previous research that identified differences in physical performance between elite and sub-elite levels of soccer and between elite and youth soccer players (Chan et al., 2011; Dowson et al., 2002; Dunbar & Power, 1997; Gissis, Papadopoulos, Kalapotharakos, Sotiropoulos, Komsis, & Manolopoulos, 2006; Hoshikawa et al., 2009; Kaplan, Erkmen, & Taskin, 2009; Lehance et al., 2009; Meylan, McMaster, Cronin, Mohammad, Rogers, & Deklerk, 2009; Reilly, Williams, Nevill, & Franks, 2000).

In line with the hypothesis, we found significant differences among the groups ($p < 0.05$) in the SJ, CMJ and DJ. The pairwise comparisons of the reactive power behaviour, however, reveal some of the supposed differences among the performance categories. The PRO group exhibits significantly ($p < 0.05$) superior performance compared to all groups in the SJ and CMJ, but only exhibits superior performance in the DJ compared to the U17 and AMAT. Higher performances in the concentric force development (SJ) and slow DVZ (CMJ) seem to depend on the level of play. This fact could be due to selection or the higher level may be due to the higher training volume. The fast SSC (DJ) appears to highlight at least one significant difference between the PRO and lower-level and youth players. This could also be caused by selection or the higher volume of training. Interestingly, there is no difference in the DJ performance between PRO, SEMI and U19, but on the basis of these data, we cannot determine why there is no difference.

In general, compared with professional soccer players and team sport athletes from other sports, the PRO group had relatively low values in the jump diagnosis (Shalfawi, Sabbah, Kailani, Tønnessen, & Enoksen, 2001; Stølen et al., 2005; Tumilty, 1993). Tumilty (1993) & Stølen et al. (2005) reported that international professional football players had similar values for the vertical bounce with the CMJ test (after Tumilty (1993): CMJ: 48-66 cm; after Stølen et al. (2005). CMJ: 39.3 to 64.8 cm). Considering that the international standard is considerably higher than the measured values in this investigation, the results of this investigation support the theory that the SJ, CMJ and DJ are key performance tests associated with a higher level of soccer performance. Studies on soccer players in the junior and senior age groups with measurements based solely on soccer training in-within the season reported no increases in the sprint and jump performance (Caldwell & Peters, 2009; LaTorre, Vernillo, Rodigari, Maggioni, & Merati, 2007). Although, in children's and youth soccer, maximal strength, jumping and sprint performance increase within several years (Hansen, Bangsbo, Twisk, & Klausen, 1999; Williams, Oliver, & Faulkner, 2011). However, these developmental power increases are limited. For youth soccer players striving to reach the highest levels of competition, reaching optimal physical development (jump and short sprint performance) is also a goal; due to the skilled aspects of the sport, the physical development of the players appears to differentiate between the levels of play. It is suggested that strength and conditioning coaches set the foundations for further physical development by focusing on the correct techniques, while developing lower body strength and speed-strength, alongside the development of appropriate technique in jumps and sprints.

In summary, we found significant ($p < 0.05$) differences among the groups (age and level of play) in the SJ, CMJ and DJ. These variables may therefore be key performance tests for youth soccer players and elite soccer players, and the results indicate that a high level of speed-strength performance is advantageous for reaching a professional level in soccer.

CONCLUSIONS

First, the data show that the tests SJ, CMJ and DJ can be a basis for assessing physical attributes. Comparisons with normative data, such as that presented in this study, can also guide a physical training program for the developing player so that he or she can achieve success at a higher level. Previous studies have reported high correlations between the different strength tests and jump and sprint tests (e.g., Baker & Newton, 2008; Bissas & Havenentidis, 2008; Dowson et al., 1998; Harris et al., 2008; Hori, Newton, Andrews, Kawamori, McGuigan, & Nosaka, 2008; Kukolj, Ropret, Ugarkovic, & Jaric, 1999; McBride, Blow, Kirby, Haines, Dayne, & Triplett, 2009; Requena, Gonzalez-Badillo, DeVillareal, Ereline, Garcia, Gapeyeva, & Pääsuke, 2009; Young, McLean, & Ardagna, 1995). Therefore, periodised strength training with the aim of improving maximum strength can be used to improve sprint and jump performance (Ronnestad et al., 2008; Tricoli, Lamas, Carnevale, & Ugrinowitsch, 2005; Tsimahidis, Galazoulas, Skoufas, Papaiakovou, Bassa, Patikas, & Kotzamanidis, 2010). For professional and youth soccer players, strength training is an appropriate means of increasing performance in the fast and slow SSC. On the one hand, strength training creates a faster start for professionals compared to youth players; on the other hand, strength training can improve the performance in the fast and slow SSC and help to develop an enhanced performance advantage for professional players. Strength training should be integrated at an early age for soccer (Faigenbaum, Kraemer, Blimkie, Jeffreys, Micheli, Nitka, & Rowland, 2009). Long-term periodisation training is indispensable. Exercises that are ideal for increasing strength and power performance include weight-lifting exercises, such as the clean and jerk and the snatch (Arabatzi, Kellis, & De Villarrea,l 2010). Parallel exercises, such as the deep neck squat and front squat, are also advised (Weiss, Fry, Wood, Relyea, & Melton, 2000). Additionally, players should train with the bench press, deadlift, and bent-over row or they should perform the shoulder press along with exercises for the strengthening trunk muscles.

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