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# INFLUENCE OF COMPETITION ON VERTICAL JUMP, KICKING SPEED, SPRINT AND AGILITY OF YOUNG FOOTBALL PLAYERS

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***ABSTRACT***

*The objective of this study was to analyse the influence of competition level (elite group [EG] and sub-elite group [SG]), on the Counter Movement Jump (CMJ), Kicking Speed (KS), sprint and agility in young football players. The subjects were 79 young football players (14 to 18 years old), from Andalusian football teams with mean parameters of 15.68 years (age), 1.74m (height), 64.93kg (weight) and 21.38kg/m$^2$ (Body Mass Index [BMI]). The results of the Analysis of Covariance showed that players in the EG performed better than the SG on all variables, after adjusting for age and BMI ($p \leq 0.028$). It was concluded that competing in a higher football division, involves higher performance levels for CMJ, KS, sprint speed and agility. This may suggest that training programmes are more effective and accurate at higher competition levels. Physical fitness could be a key factor in determining the level of a player at these ages. These football-specific skills could be used for designing and evaluating training programmes to improve the level of conditioning.*

**Key words:** Power; Strength; Football-specific skills; Football division; Young players.

## INTRODUCTION

In recent years, a growing number of studies have evaluated the physical and functional abilities of football players in formative categories (Gissis *et al.*, 2006; Gil *et al.*, 2007; Le Gall *et al.*, 2010; Gissis, 2012; García-Pinillos *et al.*, 2014a; García-Pinillos *et al.*, 2014b; García-Pinillos *et al.*, 2015). In this respect, the role of control and monitoring of these parameters along this evolution stage is vital in the long-term development of football players and may determine future sporting performance (Gil *et al.*, 2007; Gravina *et al.*, 2008; Le Gall *et al.*, 2010; García-Pinillos *et al.*, 2015). This research line supports the hypothesis that a good physical capacity in football influences the technical performance, as well as tactical decisions, and may reduce the risk of injury (Stølen *et al.*, 2005).

The adolescent stage is the most susceptible period in development of physical abilities (Gissis, 2012; García-Pinillos *et al.*, 2014a). At this stage, a significant increase in skeletal muscle mass and strength, and a better development of anaerobic capacity and agility have been observed (Malina *et al.*, 2005; Philippaerts *et al.*, 2006). The basic movement patterns in football require rapid force development and high-power output, as well as the ability to use the stretch-shortening cycle in ballistic movements efficiently (Thomas *et al.*, 2009; García-Pinillos *et al.*, 2014a). From this conditioning view, the most interesting events during a football match are represented by high-intensity work, such as sprint, turns, jumps, shots or tackles (Hoff & Hegerud, 2004). In this regard, previous studies have shown that muscle strength, power and speed are the most important physiological characteristics of football players (Reilly *et al.*, 2000; López-Segovia *et al.*, 2011). Moreover, jumping, kicking speed (KS), sprint or agility are highly correlated among themselves, and could be the better options to assess the football player performance (Comfort *et al.*, 2014; García-Pinillos *et al.*, 2014b).

As far as the authors know, just a limited number of studies have focused on sport performance differences between different competition levels in young football players. These studies use a wide variety of tests (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis 2012). Likewise, standard values are unclear and important football-specific parameters such as KS or agility have been analysed poorly (Le Gall *et al.*, 2010; Papaevangelou *et al.*, 2012).

There are other studies with similar characteristics but they are focused on senior football players (Gissis, 2013; Ricotti *et al.*, 2013), specific positions (Gil *et al.*, 2007; García-Pinillos *et al.*, 2014b), or an age category (García-Pinillos *et al.*, 2015). Thus, it is still unclear whether playing in a higher division can lead to better football-specific abilities in young football players.

## PURPOSE OF THE RESEARCH

The main objective was to analyse the influence of competition level (elite and sub-elite) on the Counter Movement Jump (CMJ), KS, sprint for 5, 15 and 20 metres (S5m, S15m, S20m) and agility in young football players. It was hypothesised that young football players from a higher competition level would produce better performance scores on the previously mentioned variables than sub-elite young football players.

## METHODS

### Participants

A total of 79 young male football players (aged: 14 to 18; Body Mass Index [BMI] of 21.38±2.28 kg/m$^2$), participated in the present cross-sectional study. They were divided into 2 groups according to competition level: the elite group (EG) (n=43) consisted of football players from national youth football teams of the south of Spain and the sub-elite group (SG) (n=36), consisted of youth football players who participated in regional competitions.

Before participating in this study, parents, coaches and players were informed about the purpose of the research. Written parental consent was obtained for participants under 18 years old. The study was conducted with adherence to the standards of the Declaration of Helsinki (2008 version), and honouring the European Community's guidelines for Good Clinical Practice (111/3976/88 of July 1990), as well as the Spanish legal framework for clinical research on humans (Real Decreto 561/1993). The parental consent and study protocol was approved by the Bioethics Committee from the Director of Research and Teaching in

Physical Activity and Health (University of Jaén, Spain). Clubs were selected taking into account the number of weekly workouts to avoid previous differences (Ricotti *et al.*, 2013). In this way, the study was developed in-season, when participants attended football training 3 times per week and additionally played competitive matches once a week on the weekend. All participants had been involved in football training with this regularity for at least 4 years before the study. Selected players belonged to under-16 and under-18 age categories.

## Instruments

***Counter Movement Jump (CMJ):*** For the CMJ, the subjects performed a maximal vertical jump starting from a standing position without using arm swing. Subjects were instructed to keep their arms in akimbo position (hands on hips and elbow out), and they were required to flex their knees to a 90º angle. The participants were experienced players who perform CMJ in their daily training sessions. Moreover, to ensure that the execution of the CMJ was correct, a familiarisation session was carried out prior to the formal testing. The maximum jumping height (m) was recorded using the FreePower Jump Sensorize (Biocorp, Italy), which has been used previously in similar studies (García-Pinillos *et al.*, 2014a). Subjects performed 3 measured trials with a 30-second recovery period after each jump. The best result of the 3 trials was recorded for analysis (García-Pinillos *et al.*, 2014a).

***Kicking speed (KS):*** The KS, in terms of ball speed ($ms^{-1}$), was measured during goal shooting. Markers were set up at 1m and 2m from the initial position of the ball. The KS was recorded with a high-speed camera (Casio Exilim EXZR-10 high-speed camera, Dover, NJ, USA) at a sampling frequency of 480 Hz for this test and was analysed by means of 2D photogrammetry. The video data were digitised using VideoSpeed (Version 1.38; ErgoSport, Granada, Spain). This methodology has also been used in similar studies previously (García-Pinillos *et al.*, 2014a). For this measurement, a ball of standard size and proper pressure according to the rules of Federation Internationale de Football Association (FIFA) was used. Each participant performed 3 trials with each leg. The best score for each leg were used for statistical analysis (Sedano-Campo *et al.*, 2009). The resting period between trials was 40 seconds. To standardise the procedure, a 2-step run-up was required. Participants were asked to kick the ball as fast as possible toward the goal with the dominant and nondominant leg alternatively. They were instructed not to decrease the speed to improve the accuracy of the shot.

***Sprint:*** Sprint evaluation was accomplished through a speed test that was carried out in a straight 20m-line (Impellizzeri *et al.*, 2008; Comfort *et al.*, 2014). Markers were set up at 5m (S5m), 10m (S10m) and 20m (S20m). In order to eliminate reaction time, the subjects started without any starting signal from a static and standing position with feet parallel behind the start line. Similar to previous studies (Chelly *et al*., 2010; García-Pinillos *et al.*, 2014a), sprint times (in seconds) were also measured through 2D photogrammetry. A lateral view of the 20m-sprint was obtained for all trials, using the same high-speed camera at a sampling frequency of 240 Hz for this test. The video camera was placed at a right angle to the running course and 15m away to obtain a sagittal image of the entire run. The video data were digitised using the VideoSpeed programme where the shoulder served as the point of interest to control the start and end of the time spent on performing the test (García-Pinillos *et al.*, 2014a).

***Agility:*** Agility was evaluated be means of the Balsom Agility Test (BAT) (Balsom, 1994). This test evaluates the capacity of the subject to change direction quickly. For sprint and agility tests, players were allowed 2 trials with a 3-minute recovery period in between. The best trial was used for the BAT (Balsom, 1994), and sprint test (Thomas *et al.*, 2009). The times (in seconds) were analysed through 2D photogrammetry in an identical way to the sprint evaluation and KS. The shoulder was considered as the body segment to serve as the start and end of the time spent on performing the test (García-Pinillos *et al.*, 2015).

**Experimental procedure**

Data was collected, following previous procedures (García-Pinillos *et al.*, 2014a), by trained members of the research group with sufficient experience in football and strength training. For the evaluation, players were measured during two different sessions separated by 24 hours. In the first session, height (m) and weight (kg) were assessed with a portable SECA 214 height scale (Seca 214, Hamburg, Germany), and a type-B class-III ASIMED weight scale (Spain), respectively. These measures were used for the BMI calculation (expressed as $kg/m^2$). The participants were examined wearing underclothes and without shoes. The first testing day was also used as a familiarisation session with the selected tests, receiving further information about the selected tests and performing them 3 to 4 times (at low-intensity) to ensure the correct execution.

The second testing session was conducted outdoors on artificial turf. Tests were performed individually and in the following order: CMJ, KS, sprint and agility. Prior to the tests, participants began the session with a standard warm-up, consisting of 5 minutes of low-intensity running and 5 minutes of general exercises (high skipping, ballistic stretching, leg flexions, lateral running, front and behind arm rotation and sprints). Participants were instructed to maximise their performance in the different tests. These instructions were emphasised by means of demonstrations and verbal cues. Participants were advised to avoid high-intensity efforts in the 72 hours prior to the testing session.

**Statistical analyses**

Descriptive statistics were presented as mean and standard deviation (SD) or frequencies and percentages (%). The best result of each test was used in the analysis (Balsom, 1994; Sedano-Campo *et al.*, 2009; Thomas *et al.*, 2009; García-Pinillos *et al*., 2014a). Differences between EG and SG based on socio-demographic variables were evaluated by applying the One-way ANOVA for continuous variables and the chi-square test for nominal variables. Differences in competition level based on the EG or SG as dependent variables were tested by One-way analysis of covariance (ANCOVA) adjusted for age and BMI. Analyses were performed using SPSS version 19.0 for Windows (SPSS Inc., Chicago). The criterion for statistical significance was $p<0.05$.

## RESULTS

Table 1 presents descriptive characteristics of the study sample. There were no differences between the EG and SG regarding age (15.68±1.45 years), weight (64.93±9.7 kg) or specific position ($p=0.914$). Considering the whole-group, 12.7% were goalkeepers, 20.3% defenders, 25.3% left and right backs, 20.3% midfielders, 11.4% left and right wingers and 10.1%

forwards. In addition, results showed that the EG were taller and had a lower BMI than SG ($p \leq 0.033$).

*TABLE 1.* **CHARACTERISTICS OF STUDY SAMPLE**

| **Variable** | **Total Gr.** (N=79) Mean±SD | **EG** (n=43) Mean±SD | **SG** (n=36) Mean±SD | **p** |
|---|---|---|---|---|
| Age (years) | 15.68±1.45 | 15.60±1.48 | 15.78±1.42 | 0.599 |
| Height (m) | 1.74±0.07 | 1.76±0.06 | 1.72±0.06 | 0.001 |
| Weight (kg) | 64.93±9.70 | 65.30±9.20 | 64.50±10.39 | 0.721 |
| BMI (kg/m$^2$) | 21.38±2.28 | 20.88±2.04 | 21.97±2.42 | 0.033 |
| **Specific position** | n (%) | | | |
| Goalkeeper | 10 (12.7%) | 6 (14.0%) | 4 (11.1%) | 0.914 |
| Defender | 16 (20.3%) | 9 (20.9%) | 7 (19.4%) | |
| Left and right back | 20 (25.3%) | 11 (25.6%) | 9 (25.0%) | |
| Midfielder | 16 (20.3%) | 7 (16.3%) | 9 (25.0%) | |
| Left and right winger | 9 (11.4%) | 6 (14.0%) | 3 (8.3%) | |
| Forward | 8 (10.1%) | 4 (9.3%) | 4 (11.1%) | |
| **Weekly training** (days) | 3 | 3 | 3 | |

EG= Elite Group SG = Sub-elite Group Significance $p<0.05$

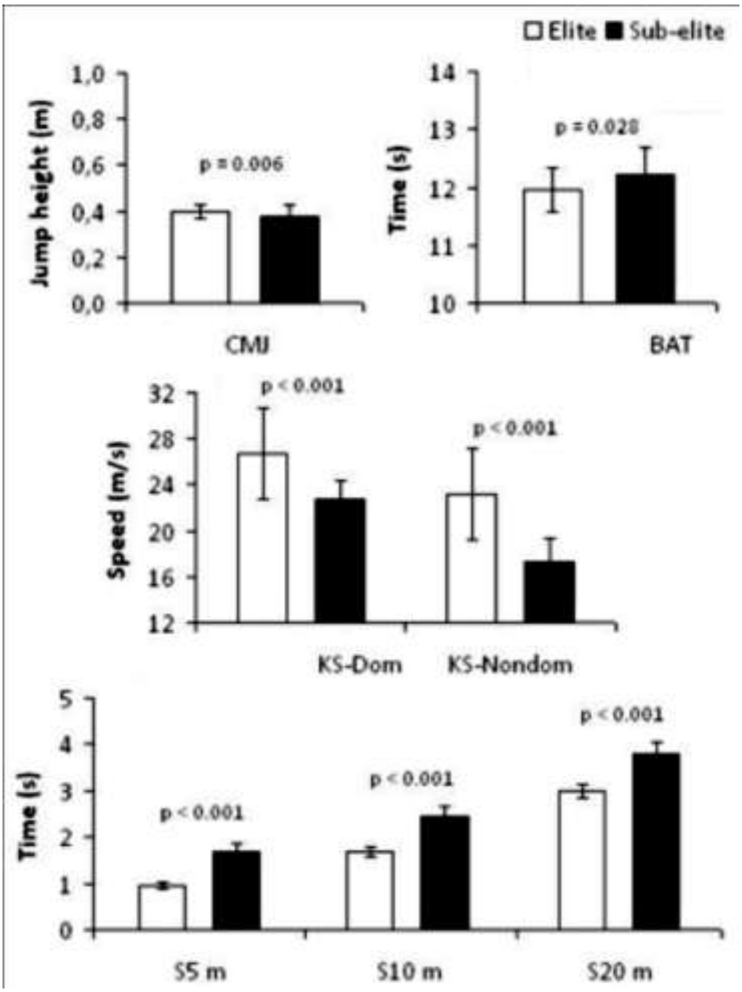
*Table 2.* **INTER-GROUP DIFFERENCES FOR ANALYSED PARAMETERS**

| **Parameters** | **Tot. Gr.** (N=79) Mean±SD | **EG** (n=43) Mean±SD | **SG** (n=36) Mean±SD | **Inter-group difference value (%)** | **p** |
|---|---|---|---|---|---|
| CMJ (m) | 0.39±0.04 | 0.40±0.03 | 0.37±0.05 | 0.03 (7.50) | 0.006 |
| KS-Dom (ms$^{-1}$) | 25.03±3.76 | 26.65±3.96 | 22.70±1.68 | 3.95 (14.82) | <0.001 |
| KS-Nondom (ms$^{-1}$) | 20.79±4.35 | 23.19±3.93 | 17.37±1.98 | 5.82 (25.10) | <0.001 |
| S5m (s) | 1.27±0.39 | 0.94±0.06 | 1.67±0.20 | 0.73 (43.71) | <0.001 |
| S10m (s) | 2.03±0.42 | 1.67±0.99 | 2.45±0.21 | 0.78 (31.84) | <0.001 |
| S20m (s) | 3.35±0.45 | 2.99±0.16 | 3.79±0.25 | 0.80 (21.11) | <0.001 |
| BAT (s) | 12.07±0.45 | 11.96±0.38 | 12.21±0.48 | 0.25 (2.05) | 0.028 |

EG= Elite Group; SG= Sub-elite Group; CMJ= Counter Movement Jump; KS-Dom= Kicking Speed dominant leg; KS-Nondom= Kicking; Speed nondominant leg; S5m= Speed-5m; S10m= Speed-10m; S20m= Speed-20m; BAT= Balsom Agility Test. Significance at $p<0.05$

From the analysis of covariance, Table 2 presents the inter-group differences for the analysed parameters. Results show that the EG displayed a superior performance than the SG on CMJ (+0.03m, 7.5%), in KS with both legs (+3.95ms$^{-1}$, 14.82% and +5.82ms$^{-1}$, 25.1% for dominant and nondominant legs, respectively), in speed (-0.73s, 43.71%; -0.78s, 31.84%; -0.8s, 21.11%; respectively for S5m, S10m and S20m), and agility (-0.25 s, 2.05%).

Analysis of covariance between the EG and SG showed that young football players in the EG had better scores than the SG on the CMJ, KS with both legs, sprint and agility after adjusting by important confounders as age and BMI (Total Group p≤0.028) (Figure 1).




CMJ= Counter Movement Jump; BAT= Balsom Agility Test; KS-Dom= Kicking Speed dominant leg; KS-Nondom= Kicking Speed nondominant leg; S5m= Speed 5m; S10m= Speed 10m; S20m= Speed 20m. Significance at p<0.05.

*FIGURE 1.* **COMPARISON BETWEEN ELITE (n=43) AND SUB-ELITE GROUP (n=36): ANALYSES ADJUSTED FOR AGE AND BMI**

## DISCUSSION

The aim of this study was to analyse the influence of competition level (EG and SG) on CMJ, KS, S5 m, S10 m and S20 m, and agility in young football players (14 to 18 years old). It was hypothesised that young football players in a higher competition level (elite) would present a superior performance than sub-elite players. The results obtained support the initial research hypothesis showing that players in the EG achieved better scores than those in the SG on the CMJ, KS with both legs, S5m-, S10m- and S20m-sprints, and agility, after taking age and BMI into account as confounder variables. To our knowledge, there are no studies that have examined the influence of competition level in young football players on BAT or KS performance and the tests used to assess the CMJ and speed are very diverse (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012). The scarcity of information about this topic makes it difficult to make comparisons in the discussion of the results obtained.

The CMJ is a popular test that has been widely used to assess the maximal vertical jump in football players (Gravina *et al.*, 2008; Juárez *et al.*, 2010; García-Pinillos *et al.*, 2014a; García-Pinillos *et al.*, 2014b; García-Pinillos *et al.*, 2015). Differences have been found between EG and SG, for young football players in a higher division in previous studies (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012; Papaevangelou *et al.*, 2012). The data collected in this study were similar to those reported by the previous studies in both the EG, with a CMJ performance of 0.40m (Juárez *et al.*, 2010; Maio-Alves *et al.*, 2010), and the SG with a CMJ performance of 0.38m, being similar scores to those obtained with amateur adults (0.38m) (Impellizzeri *et al.*, 2008; López-Segovia *et al.*, 2011).

Focusing on KS, the results show that players in the EG achieved superior scores than the SG with both legs. Although this ability is strongly associated with other specific football strength abilities, such as vertical jump or sprint (Juárez *et al.*, 2010; García-Pinillos *et al.*, 2014b), most of the studies did not include this test to assess the performance in young football players (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Maio-Alves *et al.*, 2010; López-Segovia *et al.*, 2011; Gissis, 2012; Papaevangelou *et al.*, 2012). Muñoz and González (2012) analysed football kick kinematic differences between experienced and non-experienced young football players, and these authors only found differences on KS for the nondominant leg.

As reported in previous studies, KS could be influenced by various factors, such as the maximal strength of the muscles involved, the rate of force development, neuromuscular coordination, the linear and angular velocities of the ankle in the kicking leg, and the level of coordination between agonists and antagonists (Hoff & Hegerud, 2004; Sedano-Campo *et al.*, 2009; Muñoz & González, 2012; García-Pinillos *et al.*, 2014a). To sum up, scientific literature about KS of football players is still sparse especially with regard to young populations (Muñoz & González, 2012; García-Pinillos *et al.*, 2014a). This calls for more research in this area.

As for the S20m-sprint test, the result obtained (2.99s) is similar to that obtained by previous studies (Impellizzeri *et al.*, 2008; Le Gall *et al.*, 2010). In the SG, players attained 3.79 seconds, which is a similar mean score to that obtained for football players with similar characteristics (García-Pinillos *et al.*, 2014a), and slightly slower than amateur senior players

(3.22s) (López-Segovia *et al.*, 2011). According to competition level, this parameter shows that the EG were significantly faster than the SG (on S5m, S10m and S20m), which is in line with previous findings reported (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012).

It is risky to compare the results obtained for agility (BAT) because of the diversity of tests used to assess this ability. In spite of this fact, it can be concluded that the results for the SG (12.21s) in the current study are similar to other studies involving non-elite players (Philippaerts *et al.*, 2006; García-Pinillos *et al.*, 2014a). Considering the difference in performance based on competition level, the current results are identical in the case of CMJ and speed tests. The players in the EG produced better performances than their peers in the SG (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012). However, comparisons with similar studies are not possible due to the absence, to the best of our knowledge, of other studies using BAT.

The magnitude of the differences for EG players in all the tests may be as a result of players in a higher division having different muscle strength levels and coordination patterns due to the training programme, which includes elements for the development of these football-specific skills (Gissis, 2012). Or it could be due to the duration, intensity and the types of the exercises used in their training, as well as other variables, such as training status or methods of testing (Markovic & Mikulic, 2010; García-Pinillos *et al.*, 2014a).

Despite its exploratory nature, this study offers some insight into influence of competition level on football-specific skills in a particular population. The present study confirms previous findings and contributes additional evidence. However, these findings are limited by the use of a cross sectional design, which does not allow for establishing causal relationships between variables. This limitation implies that the findings of this study need to be interpreted cautiously.

## CONCLUSION

In conclusion, young football players in the EG obtained better scores than the SG on the vertical jump (7.5%), KS with both legs (14.82% and 25.1% for dominant and non-dominant, respectively), S5m-, S10m-, S20m-sprints (43.71%, 31.84% and 21.11% respectively), and agility (2.05%). This suggests that young elite football players participating at a higher level exhibit superior physical capacities than those participating at a sub-elite level. This fact might suggest that training programmes are more effective and precise (more accurate training prescription), at higher competition levels, where physical fitness is also important when determining the level of players at these ages. From a practical point of view, these football-specific skills can be used when designing and evaluating training programmes to improve the conditioning level. Finally, improved levels of conditioning would be a key factor to consider for football players at a lower level, as it could lead to improving sport performance.

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