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Original Article

Vertical jump performance in Italian elite Trials athletes

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Abstract

This research aims to provide data on explosive and reactive strength characteristics of Italian elite Trials athletes, through vertical jump tests. Five elite athletes (age: 19.6±3.3 y; height: 1.80±0.04 m; body mass: 71.7±7.4 kg) all participating in the Trials World Cup, performed the squat jump and the countermovement jump tests. The height of the jumps was measured using the OptoJump Next (Microgate, Bolzano, Italy). The height of the jump was obtained, then the eccentric utilization ratio (EUR) was calculated as a ratio between the heights of CMJ and SJ, mean and standard deviation of the sample were obtained through a descriptive statistical analysis. Furthermore, a comparison was made between the values obtained and values found in the scientific literature for elite athletes from other sports. From research carried out exclusively data on high-level athletes and performed with OptoJump technology were collected, all studies not corresponding to these criteria were excluded from the analysis. The results show that the Italian elite Trials athletes have good explosive and reactive strength as shown in the SJ (41.0 ± 2.4cm) and in the CMJ (44.0 ± 4.5cm), they also display good performance in comparison to athletes of the same level in other sports, similar to those of hurdlers and volleyball players, also the EUR above 1 (1.07 ± 0.5) suggests that they are well-trained athletes. The results obtained, although on a small sample, provide useful data to describe the athletic profile of Italian elite Trials athletes and could help coaches to structure training programs adapted to the specific demands of this sport.
Key words: trials, cycling, vertical jump, optojump, eccentric utilization ratio, stretch shortening cycle.

Introduction

Trials is a cycling competition, the objective of this sport is to get over obstacles grouped into sections, without setting foot on the ground or on the obstacle or any part of the bicycle (only the tires) touching the ground or on the obstacle as this incurs penalty points. The rider with the lowest total of penalty points shall be declared the winner. The total duration of the competition, necessary to negotiate all sections, is two minutes (U.C.I. 2018). Trials, although belonging to the cycling specialties, differs a lot from these due to the nature of the gestures performed, indeed the athlete must jump up and down the obstacles in a position very similar to a two-legged jump. From these premises it is clear that the vertical jump has great importance in Trials and therefore its evaluation. Vertical jump height is commonly used in sports to evaluate athletes, Bosco in the '80s defined a test battery to assess indirectly the lower body strength and power (Bosco et al. 1983), among the tests the squat jump (SJ) and the countermovement jump (CMJ) respectively evaluate explosive manifestation of strength and reactive manifestation of strength (de la Fuente et al. 2013). Explosive strength, is the ability to develop force within a very short time (Zatsiorsky et al. 2006), the reactive strength is instead the capacity to rapidly switch from an eccentric action to a concentric action through a stretch-shortening cycle (SSC) (Cavagna et al. 1968; Asmussen et al. 1974; Bosco et al. 1982). This eccentric-concentric coupling produces a more powerful contraction than a purely concentric action alone (Komi 2008). The SSC appears to be the natural form of muscle function and it is observed in a wide range of activities, furthermore, exercise seldom involves a pure form of concentric action (Komi 2000). The SSC can be classified as either slow or fast, the fast SSC is characterized by short contraction times (<0.25s) and small angular displacements, the slow SSC involves longer contraction times and larger angular displacements like in a vertical jump (Komi 2008). Performance enhancement in slow SSC activities may be primarily due to the slow eccentric phase allowing an increased time to develop force (Bobbert et al. 1996; Walshe et al. 1998). It has been hypothesized that the slow and fast SSC may represent different muscle action patterns, reliant on differing biomechanical mechanisms which can affect performance in different ways (Flanagan 2007). By comparing the jump performance between the tests, it is possible to calculate the eccentric utilization ratio (EUR) which gives information on the athlete's ability to use the SSC (McGuigan et al. 2006; Riggs et al. 2009). The aim of this study is to evaluate the jumping ability of Italian elite athletes and to compare the vertical jump performances of Trials athletes with those of high-level athletes from other sports disciplines. An analysis of the literature shows how few studies are related to this discipline (Bertucci et al. 2015; Vastola et al. 2016; Vastola et al. 2017) and that today there is no similar study, therefore this work is a pilot study to expand the knowledge on the characteristics of athletes practicing Trials.

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Material & methods

Participants and procedure

This research involved five men (age: 19.6±3.3 y; height: 1.80±0.04 m; body mass: 71.7±7.4 kg), practicing Trials at the Italian elite level, participating in the Trials World Cup. The athletes were informed of the experimental risks and signed an informed consent form prior to the investigation. The tests were performed at the end of the racing season in conjunction with the Trials World Cup final. Anthropometric data (height and weight) were collected. Athletes performed a 15 minutes warm-up that included joint mobility and some dynamic exercises. After the warm-up, the athletes performed a series of sub-maximal jumps to become familiar with the movements required by the test (KRČMÁR et al: 2016; Galazoulas 2017).

Two vertical jump tests were performed, the squat jump (SJ) and the countermovement jump (CMJ). Each type of jump was performed three times with a 30 seconds recovery between the trials and a 2 minutes recovery between the jump types. The first three SJs were performed, followed by the three CMJs. The SJ was performed from an initial static position with a 90° knee flexion. Participants were instructed to hold the squat position for 3 seconds before jumping. For CMJ tests, participants could choose the countermovement in order to avoid changes in the jumping coordination pattern. For both tests, players were instructed to keep their hands on their waist during the jump.

Additionally, an experienced researcher conducted tests and visually checked for countermovement during the SJ in order to ensure the correct technique. The jump height was evaluated with OptoJump Next (Microgate, Bolzano, Italy) which proved to be a reliable instrument for the evaluation of the vertical jump (Glatthorn et al. 2011; Santos-Lozano et al. 2014; Attia et al. 2017; Słomka et al. 2017). The OptoJump system consists of two parallel bars (a receiver and a transmitter unit), each contains 96 LEDs, the LEDs located on the transmitting bar continuously communicate with those on the receiving bar, the system detects any interruptions of the signal and calculates the duration with an accuracy of 1 ms. The OptoJump bars were placed approximately 1 m apart and parallel to each other and were connected to a personal computer. Jump height was measured using proprietary software (OptoJump software; version 1.12.15.0). The best attempt at SJ and CMJ was used for data analysis.

Data collection and analysis

The OptoJump system measured the flight time of the jump with an accuracy of 1 ms. Jump height was estimated using the equation by Komi et al. 1978.

The ratio between the heights of CMJ and SJ was used as a eccentric utilization ratio (EUR) (McGuigan et al. 2006; Riggs et al. 2009).

To find reference values, an analysis of the scientific literature was conducted by selecting the studies based on the sample and the instrumentation used. Data from research carried out exclusively on high-level athletes and performed with OptoJump technology were collected, all studies not corresponding to these criteria were excluded from the analysis. Six studies were selected, data were collected on elite volleyball athletes (Sattler et al. 2015), handball (Moncef et al. 2012; Nikolaidis et al. 2013), soccer (Castagna et al. 2013), basketball (Schiltz et al. 2009) and 400m hurdles (Balsalobre-Fernnádez et al. 2013).

Statistical analysis

Mean and standard deviation for all the attributes age, height, body mass and values related to vertical jump tests were calculated.

Results

Table 1 shows the characteristics of the sample, age 19.6±3.3 years, height 1.80±0.04 m, body weight 71.7±7.4 kg and the average jump performance recorded during the tests. In the SJ test the sample shows a value of 41.0±4.5 cm, in the CMJ test 44.0±4.5 cm. The EUR is also shown with a value of 1.07±0.5.

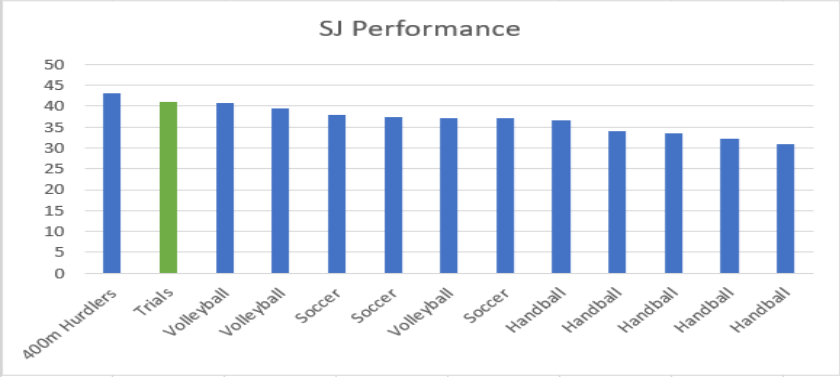
Table 1 Sample data, anthropometrics and test performance values.

N° of athletes	Age (years)	Height (m)	Mass (kg)	Squat Jump Height (cm)	Counter Movement Jump Height (cm)	Eccentric Utilization Ratio
5	19.6 ± 3.3	1.80 ± 0.04	71.7 ± 7.4	41.0 ± 2.4	44.0 ± 4.5	1.07 ± 0.5

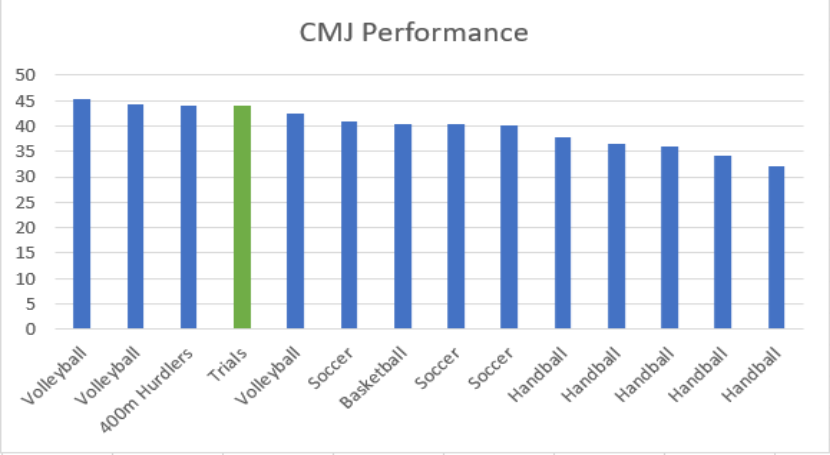
The data collected in the literature on athletes from other sports were reported in Table 2. The sports shown are football, volleyball, handball, 400m hurdles and basketball. The number of subjects making up the sample in the various studies varies from 7 to 95.

Table 2. SJ e CMJ values from other authors.

Authors	N° of Athletes	Sport	Squat Jump Height (cm)		Counter Movement Jump Height (cm)	
			Mean	Standard Deviation	Mean	Standard Deviation
Balsalobre-Fernández et al. (2013)	7	400m Hurdlers	43		44	
Castagna et al. (2013)	21	Soccer	37.3	4.7	40.9	5.1
	18		37	3.9	40.3	4.3
	17		38	4.9	40.2	4.7
Moncef et al. (2012)	42	Handball	32.1	3.1	34.1	4.4
Nikolaidis et al. (2013)	14	Handball	36.5	4.5	37.7	3.7
	17		33.5	4.7	36.4	5.7
	39		33.9	4.8	35.9	5.3
	13		31	4.8	32.2	6.2
Sattler et al. (2015)	48	Volleyball	40.8	5.6	45.3	4.9
	95		39.5	5.3	44.37	4.9
	52		37.2	4.1	42.5	5.2
Schiltz et al. (2009)	15	Basketball			40.5	5.7



Graph 1 SJ performance values comparison. Values are expressed in cm.



Graph 2 CMJ performance values comparison. Values are expressed in cm.

Graph 1 shows on the y-axis the jump performance in the SJ test expressed in cm, on the x-axis the sport. The performance obtained by the Trials athletes was highlighted in green. Graph 2 shows the jump performance in the CMJ test expressed in cm on the y-axis, the sport on the x-axis. The performance obtained by Trials athletes was highlighted in green.

Discussion

As the results show, Trials athletes display rather high jump values both in the SJ (41.0 ± 2.4cm) and in the CMJ (44.0 ± 4.5cm), which suggests that these athletes possess good explosive and reactive strength. Compared to the athletes of the same level of other sports disciplines, in the SJ test they show higher values than all the others, with the exception of the 400m hurdles athletes that show higher values (43cm), moreover they are similar to those of the volleyball athletes (40.8±5.6cm). In the CMJ test the values of the Trials athletes are

higher than the soccer and handball athletes, equal to the 400m hurdlers and lower than the volleyball athletes (45.3 ± 4.9cm). The EUR above 1 (1.07 ± 0.5) suggests that they are well-trained athletes (McGuigan 2006; Riggs et al. 2009; Haff et al. 2010), however they seem to show lower values than those of soccer (1.14 ± 0.15) or rugby athletes (1.13 ± 0.14) (McGuigan et al. 2006) and similar to those of beach volleyball athletes (1.05 ± 0.05) (Riggs et al. 2009). However, it seems that the role of the SSC and the use of elastic energy is sport specific and linked to the training regimen (McGuigan et al. 2006; Riggs et al. 2009; Impellizzeri et al. 2008). It should also be emphasized that in Trials during loading movements the tire is compressed to take advantage of its elasticity characteristics to jump higher and this could somehow affect the muscle control strategy that the body adopts during the SSC.

Conclusions

The results obtained, although on a small sample, provide useful data to describe the athletic profile of Italian elite Trials athletes. Although Trials is a sport in which the technique has a very important role, based on the data collected it is possible to state that to compete at high level in the Italian championship it is necessary to have certain characteristics of explosive and reactive strength. This work represents a first step in the study of this discipline and in the description of the characteristics that a Trials athlete should possess. The results obtained contribute, albeit modestly, to the scientific knowledge on this discipline and therefore could help coaches to structure training programs adapted to the specific demands of this sport.

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