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Research Paper

Muscle strength and anaerobic performance in football players with cerebral palsy

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Abstract

Background: This is the first study that quantified the anaerobic performance in football players with cerebral palsy (CP).

Objective: This study aimed to examine anaerobic fitness in a population of football players with CP using vertical jumping (VJ) and Wingate tests.

Methods: Twelve players (age 26.8 ± 4.8 yr, body mass 66.2 ± 4.8 kg, height 173.7 ± 6.4 cm, body mass index 22.2 ± 1.9 kg m^{-2}) from the Spanish National Football Team with CP which had 9.4 ± 3.7 years of playing experience performed the VJ and Wingate anaerobic tests.

Results: Vertical jump height was 20.0 ± 1.2 cm for squat jump (HSJ) and 23.9 ± 5.4 cm for countermovement jump (HCMJ). Wingate test peak power (PPOW) was 490.6 ± 125.8 W (7.35 ± 1.53 W kg^{-1}). HCMJ was largely ($r = -0.631$, $p = 0.028$) and very-largely ($r = -0.710$, $p = 0.01$) associated with PPOW (W kg^{-1}) and mean power output (MPOW) (W kg^{-1}), respectively. Squat jump test peak power (W) showed a large association ($r = -0.656$, $p = 0.021$) with MPOW (W and W kg^{-1}). The CMJ height resulted 19.5% higher than SJ.

Conclusions: Results showed low VJ and anaerobic capacity of football players with CP compared to national players without CP and the general population. In football players with CP the difference (19.5%) between VJ with or without countermovement (CMJ-SJ) was higher than reported for national players without CP. Further studies examining the effect of football practice on neuromuscular performance in subjects with CP are warranted.

Keywords: Physical impairment; Muscle function; Vertical jump; Physical performance; Wingate test

Cerebral palsy (CP) is the third most common major developmental disability, after autism and intellectual impairment.[1] Its manifestations are the result of a non-progressive brain lesion, injury, or malformation occurring prenatally or in the first 2 years of life.[1] CP is characterized by a heterogeneous group of neuromotor conditions, involving muscle weakness and disordered movement or posture.[2]

Football is one of the most popular sports among participants with CP, and the number of football players with CP at a competitive level has increased in recent years.[3] Football for people with CP is a 7-a-side game with two 30 min halves; all players must have an International Federation of Cerebral Palsy Football (IFCPF)[3] classification ranging from class (FT) 5 to 8.[4,5] Football players in class FT 5 have a diplegic impairment with athletes in class FT 6 reporting quadriplegic impairment, with moderate to severe athetoid, ataxic, spastic, or mixed involvements. Football players in class FT 7 have hemiplegia, with moderate hyperthonia and, finally, athletes in class FT 8 are minimally impaired and can be monoplegic, hemiplegic, or diplegic, with spasticity, athetosis, or both.[6,7]

Football is considered an intermittent activity; the game takes place over an extended time period and is characterized by numerous short periods of high or maximum intensity exercise, interspersed with brief recovery periods.[8,9] Both aerobic and anaerobic energy systems must be activated to meet the energy demands of the muscles during play.[8,9] Therefore, many studies have reported the need to

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assess both systems to determine the fitness level of elite football players.[9,10] Anaerobic fitness is considered equally as important as aerobic capacity (endurance) in football performance.[11] Indeed during a football match, players perform several dynamic movements (i.e. kicks, sprints, tackling, and jumps), which require high strength and power of the lower limbs.[12] Therefore, measurements of muscle power are usually included in the evaluation of anaerobic fitness in football players.

The Wingate anaerobic test and the vertical jump (VJ) test are most often used to assess anaerobic capacity and power respectively.[13] The Wingate 30 s all-out test is considered as one of the most popular and reliable anaerobic tests.[8,14] It has been used in recreational and elite football[8,15,16] and was validated in children with CP[17] and in individuals with spastic CP.[18] The VJ tests have also been shown to be a suitable tool to determine anaerobic fitness.[19] Indeed VJ tests have been widely used to assess lower-limb power level of football players, either as the only characterization test,[10,20–23] or in combination with the Wingate test.[13,24,25]

Previous studies have described the anaerobic capacity in children, adolescents and adults with CP[17,18,26–28] and in athletes with CP.[6,29] However, despite the importance of anaerobic capacity in elite football performance,[30] and the necessity of knowing the anaerobic capacity of people with CP who practice this sport,[5] we are unaware of any study that assessed the anaerobic capacity of football players with CP. Such information would be useful to describe the anaerobic fitness of football players with CP and for population-specific training prescription. Therefore the aim of the present study was to determine the anaerobic fitness (measured by VJ and Wingate test) of football players with CP, and to examine the relationship between the performance achieved in both tests. As CP is associated with a functional impairment, our work hypothesis was that football players with CP have a lower anaerobic fitness than football players without CP.

Methods

Participants

This study included 12 participants with the Spanish National Football Team with CP (age 26.8 ± 4.8 years, body mass 66.2 ± 4.8 kg, height 173.7 ± 6.4 cm, body mass index 22.2 ± 1.9 kg m^{-2}, 9.4 ± 3.7 years of playing experience). All participating athletes trained 4–5 days per week, and none performed specific strength training. All players had been assigned CPISRA and Spanish Sport Federation classifications for people with CP (Table 1).

Prior to involvement in the investigation, all participants gave their written informed consent, as outlined in the Declaration of Helsinki (2013). The participants had the option to voluntarily withdraw from the study at any time without penalty. The study was approved by the Ethics Committee of the Spanish Sports Federation for people with cerebral palsy.

Table 1
Participants' IFCPF classification and impairment characteristics

Player	CPC	Position	PA	TSST (yr)
P1	5	Goalkeeper	SD	9
P2	6	Goalkeeper	AT	12
P3	6	Defender	AT	2
P4	7	Defender	SH	9
P5	7	Defender	SH	1
P6	7	Defender	SH	5
P7	6	Midfielder	AT	2
P8	7	Midfielder	SH	2
P9	8	Midfielder	SD	4
P10	7	Striker	SH	11
P11	7	Striker	SH	3
P12	8	Striker	SH	7

IFCPF = International Cerebral Palsy Football Federation; CPC = IFCPF classification; PA = predominant affectation; SD = spastic diparesia; SH = spastic hemiplegia; AT = athetosis; TSST = time in the Spanish football team.

Procedure

Anaerobic fitness was considered as a relevant component of football performance with differences related to age, competitive level and fitness.[9] The ability to perform VJ was related to competitive level in professional male and female players.[31,32] Specifically the squat jump (SJ) and countermovement jump (CMJ) have been shown to possess construct-validity in professional football players and to be related to championship ranking.[31,32]

Recently maximal efforts over short exercise-periods (i.e. 30 s) were considered as a relevant component of match performance and training in competitive football.[33,34] This promoted interest in laboratory test like Wingate test (i.e. 30 s) for the evaluation of players' anaerobic capacity.

The tests considered in this study were carried out during the pre-season, while the Spanish National football Team with CP was in preparation for the final phase of the Football 7 World Cup for people with CP. Wingate tests and VJ tests were performed on alternate days. No strenuous exercises were performed during the 48 h immediately prior testing. Two days before the testing sessions, the participants underwent 45 min of test practice to master the VJ and Wingate test procedures. However all players were familiarized with the test procedures used in this study as they were part of test routines used during their previous competitive season.

In this study a descriptive-comparative design was used. Difference between the football players with CP and the reference populations of football players without CP were performed using a systematic revision of the limited literature available. The magnitude of the differences between this study's results and the literature data were assessed using the effect size method according to Cohen.[35]