Science & Sports 39 (2024) 377—383

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Elsevier Masson France EM|consulte www.em-consulte.com

ORIGINAL ARTICLE

Age does not influence the physical performance of football players with cerebral palsy

L'âge n'influence pas les performances physiques des joueurs de football atteints d'infirmité motrice cérébrale

I. Peña-González[a], M. Henríquez[b], J.M. Sarabia[a,c], M. Moya-Ramón[a,*]

[a] *Department of Sport Sciences (Sport Research Center), Miguel Hernández University, Elche, Spain*
[b] *Escuela de Kinesiología, Facultad de Odontología y Ciencias de la Rehabilitación, Universidad San Sebastián, Providencia, Chile*
[c] *Alicante Institute for Health and Biomedical Research (ISABIAL Foundation), Alicante, Spain*

Reçu le 24 septembre 2021 ; accepté le 7 octobre 2023
Disponible sur Internet le 18 May 2024

KEYWORDS
CP football ;
Para-sport ;
Disability ;
Brain injury

Summary The aims of this study were to compare the physical performance profile of football players with cerebral palsy (CP), according to their age, consider the sport class (FT1, FT2, and FT3), and analyse the relationship between their age and their physical performance. The physical performance of seventy-five CP football players from the Spanish CP Football National Competition was assessed. A one-way analysis of variance did not reveal physical performance differences between CP football players classified into four age-groups (< 20; 20—29.9; 30—34.9; > 35vyears). The Pearson's correlation analysis did not show a correlation between players' physical performance and their age, except for dribbling ability in the overall sample ($r = 0.25$; $P = 0.037$). The linear regression analysis showed that the age only predicted the dribbling ability ($\beta = 0.25$; $P < 0.05$) but with low explained variance ($R^2 = 0.06$). The main finding of the present study reveals no systematic differences in physical performance between CP football players according to their age.

* Corresponding author at: Sport Research Centre of Miguel Hernández University, Department of Sport Sciences, Avda. de la Universidad s/n, 03202 Elche, Spain.
Adresse e-mail : mmoya@umh.es (M. Moya-Ramón).

https://doi.org/10.1016/j.scispo.2023.10.003

MOTS CLÉS
Football CP ;
Para-sport ;
Invalidité ;
Lésion cérébrale

Résumé Les objectifs de cette étude étaient (1) de comparer le profil de performance physique des joueurs de football porteurs d'une infirmité motrice cérébrale (IMC), en fonction de leur âge, et en considérant la classe sportive (FT1, FT2 et FT3), et (2) d'analyser la relation entre leur âge et leur performance physique. Les performances physiques de soixante-quinze joueurs de football avec IMC participant à la compétition nationale espagnole de football ont été évaluées. Une analyse unidirectionnelle de la variance n'a pas révélé de différences de performances physiques entre les joueurs de football IMC classés en quatre catégories d'âge (< 20 ; 20—29,9 ; 30—34,9 ; > 35 ans). L'analyse de corrélation de Pearson n'a pas montré de corrélation entre les performances physiques des joueurs et leur âge, à l'exception de la capacité de dribble dans l'échantillon global ($r = 0,25$; $p = 0,037$). L'analyse de régression linéaire a montré que l'âge ne prédisait que la capacité de dribbler ($\beta = 0,25$; $p < 0,05$) mais avec une faible variance expliquée ($R2 = 0,06$). Le principal message de cette étude est que pour les tranches d'âge considérées, il n'existe aucun effet détectable de l'âge sur les performances physiques des joueurs de football IMC.

1. Introduction

Cerebral palsy football (CP football) is a 7-a-side modality practiced by para-athletes with cerebral palsy (CP) or acquired brain injury, who present neurological and neuromuscular disorders. To be eligible for CP football competitions, players must have a minimum impairment of hypertonia, athetosis, or ataxia, with motor consequences on activity limitations and impacting several football skills [1]. In this way, the classification system provides a structure to the competition [2], in which para-footballers are classified into three profiles according to the affected body region (i.e. unilateral spasticity, bilateral spasticity, and coordination impairments) and the severity of the impairment profile (i.e., severe profile [FT1]; moderate profile [FT2]; mild profile [FT3]) [3,4].

Like other team sports, CP football is a multifaceted intermittent discipline in which the physical performance is related to high-intensity and multidirectional activities requirements supplied by aerobic and anaerobic energy systems [5]. CP para-footballers demonstrate particular physical characteristics in components such as accelerations/decelerations [6], changing of direction [7], repeated sprinting ability [8] or jumping capacity [9] showing differences according to their functional profiles. Traditionally, the assessment of these actions related to the physical performance allows coaches and sports scientists to monitor and compare players' physical improvements, which are considered a component in talent identification programs, with the aim of selecting them to participate in better teams and receive specialized training to reach professional levels [10]. In conventional football, players are usually grouped according to their age for talent identification and development to ensure a fair system in which young players practice and compete in theoretically equal conditions [11]. Additionally, Dendir [12] suggests that professional football players reach their peak performance between the ages of 25 and 27, considering the highest level of demanding physical, technical, and tactical requirements needed to succeed in the game. Besides, previous studies described that in different stages of player development, the comparison across age groups shows decline differences in physical fitness and match performance, suggesting the possible influence of the effects of aging in non-impaired football players [13,14]. Moreover, most physical performance variables such as total distance, number of sprints, high-intensity running, maximum speed [14,15], jump capacity [16] and change of direction ability [17] have been related to the impact of the player's age effects.

Although it has been shown that physical and competitive performance is dependent on the players' age in regular sport [18], limited information is available in Paralympic sports, in which only a few studies have explored the age-related patterns and peak performance in para-athletes and wheelchair athletes [19,20]. According to Schipman et al., the age of peak performance varied depending on sex, impairment classification, and event in para-athletics, showing a similar pattern to non-impaired athletes. However, contrary to para-athletics, CP football is a discipline constrained by open motor skills and specific sports dynamics in which the age effects could have a differentiated influence on the development and sport performance of the para-footballers [4,15]. Moreover, the impairments characteristics of people with CP could influence the manner of learning motor skills, aspects which need to be considered to favour the development using adequate motor training strategies in young para-athletes with neuromuscular problems [21].

For this reason, it is crucial to investigate how age impacts the physical fitness components in CP football players, in which the competition is not divided by age categories and in which the participants train and compete together independently of their age. To the authors' knowledge, there is no study in the literature comparing the physical performance across age groups and that analyses the impact of the age in para-footballers with CP. Facing this approach would provide helpful information to understand player development and the effects of age. Therefore, the aims of this study were to compare the physical performance profile of CP football players according to their age, and considering the sport class (i.e., FT1, FT2, and FT3) and to analyse the relationship between age and the physical performance of these CP football players from the Spanish national competition. The authors hypothesized that the

physical performance of CP football players will be not different according to the age categories, especially in players with less impairment impact (FT3). In players with higher level of impairment, the declines in motor function with the age could influence the players' physical performance at different ages.

2. Methods

2.1. Participants

Seventy-five CP football players from the Spanish CP Football National Competition participated in the study (FT1 [$n = 38$; age: 28.50 ± 9.05 yr; body height: 170.83 ± 8.34 cm; body weight: 66.46 ± 13.68 kg; body mass index (BMI): 22.63 ± 3.41 kg·m^{-2}; training experience: 7.53 ± 4.88 yr]; FT2 [$n = 29$; age: 28.24 ± 10.87 yr; body height: 172.93 ± 7.68 cm; body weight: 68.09 ± 12.04 kg; BMI: 22.76 ± 3.85 kg·m^{-2}; training experience: 6.17 ± 5.93 yr]; FT3 [$n = 8$; age: 28.63 ± 9.04 yr; body height: 173.06 ± 6.19 cm; body weight: 66.21 ± 6.74 kg; BMI: 22.27 ± 3.56 kg·m^{-2}; training experience: 8.63 ± 9.04 yr]). Additionally, based on a previous study [15], players were also classified according to their age. Although Rey et al. established five age groups (< 20, 20—24.9, 25—29.9, 30—34.9 and > 35), for the present study players were grouped into four groups according to their ages due to the limited number of players: G1 (< 20 yr, $n = 17$), G2 (20—29.9 yr, $n = 24$), G3 (30—34.9 yr, $n = 15$) and G4 (> 35 yr, $n = 19$). All players were registered in the Spanish Sports Federation of People with Cerebral Palsy (FEDPC). All the teams belonging to the FEDPC participated in the study, and thus, the sample of players represents the Spanish CP football. All the participants and the parents/guardians of minor players signed an informed consent according to the Declaration of Helsinki (2013).

2.2. Measures

Players' body weight was assessed by a digital Body Composition Monitor (Tanita Bc 601 Ltd., India ± 0.1 kg) and players' body height by a fixed stadiometer (SECA Ltd., Germany ± 0.1 cm). Their BMI was calculated as: weight (kg)/[height (m)]^2. Before the physical performance assessment, players performed a 10-min warm-up consisting of low-intensity displacements, dynamic stretching, and high-intensity actions (i.e., jumps, sprints, or rapid changes of direction). CP footballers performed a free (allowing arm swing) countermovement jump test (CMJ), and the jump height was evaluated using a contact platform (Globus Ergotester®, Italy). The participants performed a 20-m sprint in a straight line with the recordings at 5-, 10- and 20-m. The change of direction and dribbling abilities were also assessed using the modified agility T-test (MAT) [22] with only forward displacements [23] with and without the ball respectively (dribbling). The time during the sprint, change of direction and dribbling tests were recorded using a photocell system (Witty System, Microgate, Bolzano, Italy), and players performed these tests on a synthetic grass pitch and with their soccer boots. For each physical performance test, players performed two attempts with a 2-min rest between attempts. The best attempt in each physical performance test for each player was recorded for further analysis. Players were verbally encouraged to perform the tests at their maximal effort.

2.3. Procedure

This is a cross-sectional study that examined the comparison of age groups and the relationship between the age and the physical performance of Spanish CP football players. Anthropometrical and physical performance data for all the participants was collected just before the first match of the Spanish National Competition in the 2019—20 season. Players were asked about their age directly, and this was confirmed by their coaches, and corroborated by the official information from the FEDPC.

2.4. Statistical analysis

Descriptive data for the players' physical performance according to their sport class and age group was presented as mean $\pm$ standard deviation. Data normality and the homogeneity of variances were tested using the Kolmogorov—Smirnov and Levene's test, respectively. A one-way analysis of variance (ANOVA) with a post-hoc test (Bonferroni) was performed to show the physical performance differences between sport classes and age groups. Additionally, a comparison between age groups was performed within each sport class to minimize the effect of the functional profile. Effect sizes (ES) were calculated using Cohen's d to quantify the magnitude of the difference among classes and age groups and interpreted as follows: above 0.8, between 0.8 and 0.5, between 0.5 and 0.2, and lower than 0.2 were considered large, moderate, small, and trivial, respectively [24]. A Pearson's correlation coefficient (r) analysis was carried out to assess the relationship between the physical performance tests and the age of the CP footballers for each sport class. This data was interpreted as trivial ($r < 0.09$), small ($r = 0.10$—0.29), moderate ($r = 0.30$—0.49), large ($r = 0.50$—0.69), very large ($r = 0.70$—0.89) and almost perfect ($r = > 0.90$) [25]. Linear regression analysis for each physical performance test was carried out in each sport class using age as the independent variable. All calculations were carried out using Microsoft Excel (Microsoft, Seattle, Washington, USA) and SPSS Statistics® (Statistical Package for the Social Sciences, Version 26.0). The level of significance was set at $P < 0.05$.

3. Results

Descriptive data of players' physical performance according to their sport class and age groups are presented in Table 1. The age of the participants ranged from 15 to 53 with a mean of 28.41 ± 9.85 years and distributed as G1 (22.67%), G2 (32.00%), G3 (20.00%), and G4 (25.33%). ANOVA analyses showed significant differences among classes for the CMJ ($F_{2,71} = 23.47$; $P < 0.001$), the 5-m sprint ($F_{2,72} = 4.12$; $P = 0.020$), the 10-m sprint ($F_{2,72} = 10.34$; $P < 0.001$), the 20-m sprint ($F_{2,72} = 13.05$; $P < 0.001$), the MAT ($F_{2,72} = 12.32$; $P < 0.001$) and the dribbling test ($F_{2,67} = 7.11$; $P = 0.002$).

Table 1 Descriptive data (mean ± standard deviation) for physical performance tests according to the sport class and age of para-footballers with cerebral palsy.

	CMJ (cm)	5-m sprint (s)	10-m sprint (s)	20-m sprint (s)	MAT (s)	Dribbling (s)
Sport class						
FT1	21.39 ± 4.95	1.34 ± 0.19	2.34 ± 0.27	4.15 ± 0.49	7.88 ± 0.97	13.81 ± 2.59
FT2	27.74 ± 4.95[a]	1.24 ± 0.14[a]	2.12 ± 0.20[a]	3.72 ± 0.35[a]	7.03 ± 0.66[a]	11.61 ± 2.96[a]
FT3	34.94 ± 5.53[a,b]	1.22 ± 0.10	2.04 ± 0.11[a]	3.51 ± 0.21[a]	6.69 ± 0.56[a]	10.72 ± 1.84[a]
Age groups						
< 20 yr (G1)	24.69 ± 8.07	1.27 ± 0.14	2.18 ± 0.24	3.86 ± 0.44	7.15 ± 0.64	11.77 ± 1.91
20—29.9 yr (G2)	25.65 ± 7.62	1.26 ± 0.16	2.17 ± 0.27	3.79 ± 0.51	7.40 ± 0.85	12.35 ± 3.65
30—34.9 yr (G3)	27.21 ± 6.44	1.31 ± 0.19	2.28 ± 0.23	4.01 ± 0.36	7.67 ± 1.34	13.54 ± 3.03
> 35 yr (G4)	24.17 ± 6.31	1.32 ± 0.19	2.28 ± 0.30	4.03 ± 0.54	7.51 ± 0.92	12.93 ± 2.50

CMJ: Countermovement jump test; MAT: Modified agility T-test; G1: group 1; G2: group 2; G3: group 3; G4: group 4.
[a] Statistical difference ($P < 0.05$) from FT1.
[b] Statistical difference ($P < 0.05$) from FT2.

Table 2 Pearson's correlation coefficient for the age of the para-footballers with cerebral palsy and their physical performance.

Variable	Age			
	Overall	FT1	FT2	FT3
CMJ	−0.048	−0.033	−0.054	−0.215
	(0.684)	(0.847)	(0.781)	(0.608)
5-m sprint	0.130	0.136	0.125	0.273
	(0.265)	(0.417)	(0.519)	(0.514)
10-m sprint	0.185	0.183	0.194	0.703
	(0.112)	(0.272)	(0.312)	(0.052)
20-m sprint	0.199	0.165	0.275	0.751
	(0.088)	(0.321)	(0.148)	(0.032)[a]
MAT	0.175	0.097	0.350	0.386
	(0.133)	(0.563)	(0.063)	(0.345)
Dribbling	0.250	0.223	0.267	0.544
	(0.037)[a]	(0.204)	(0.162)	(0.207)

CMJ: Countermovement jump test; MAT: Modified agility T-test.
[a] Statistical difference ($P < 0.05$).

Pairwise comparison between player sport classes revealed significant differences in all physical tests between FT1 and FT2, and between FT1 and FT3 ($P < 0.35$, ES = 0.59 to −2.54, *moderate* to *large*), except the 5-m sprint ($P = 0.182$, ES = −0.66, *moderate*). Regarding the results of the physical test and the player age, no significant differences were found in the ANOVA comparison between groups ($P > 0.05$) and in the pair comparison between age groups ($P > 0.05$, ES = 0.01 to −0.69, *trivial* to *moderate*).

The correlation analysis between the age of the players and the results of the physical performance tests is presented in Table 2. Considering overall results, only the Dribbling test correlated significantly with the age variable ($r = 0.25$, $P = 0.037$, *small*). Also, considering the FT3 player sport class, there was a *very large* correlation between age and the 10-m sprint ($P = 0.052$, $r = 0.703$), and with the 20-m sprint ($r = 0.75$, $P = 0.032$). Linear regression analysis revealed no systematic physical performance prediction by the age, except for Dribbling ($\beta = 0.25$, $P = 0.037$, $R^2 = 6\%$) in the total sample and for the 20-m sprint ($\beta = 0.75$, $P = 0.032$, $R^2 = 56\%$) in the FT3 sport class (Table 3).

4. Discussion

The aims of this study were to compare the physical performance profile of CP football players according to their age, and considering the sport class (i.e., FT1, FT2, and FT3) and to analyse the relationship between age and the physical performance of these CP football players from the Spanish national competition. To the authors' knowledge, there is no study in the literature comparing the physical performance across age groups and that analyses the impact of the age in para-footballers with CP. The main finding of the present study reveals no systematic differences in physical performance between CP football players according to their age.

The physical performance in this study was evaluated with anaerobic physical tests because the anaerobic metabolism is a decisive component used in sprints and jumps which could influence game results [26]. CP football players demonstrated lower performance in this kind of tests than non-impaired football players [27]. In addition, the literature has shown the existence of physical differences in these

Table 3 Linear regression values using the age as the independent variable considering overall sample and each player sport class for CMJ, 5-m sprint, 10-m sprint, 20-m sprint, MAT and dribbling.

	Overall results				FT1				FT2				FT3			
	B	SE	β	R^2	B	SE	β	R^2	B	SE	β	R^2	B	SE	β	R^2
CMJ	−0.04	0.09	−0.05	0.01	−0.02	0.09	−0.03	0.01	−0.03	0.11	−0.05	0.01	−0.11	0.20	−0.22	0.05
5-m sprint	0.01	0.01	0.13	0.02	0.01	0.01	0.14	0.02	0.01	0.01	0.13	0.02	0.01	0.01	0.27	0.07
10-m sprint	0.01	0.01	0.19	0.03	0.01	0.01	0.18	0.03	0.01	0.01	0.19	0.38	0.01	0.01	0.70	0.49
20-m sprint	0.01	0.01	0.20	0.04	0.01	0.01	0.17	0.03	0.01	0.01	0.28	0.08	0.01	0.01	0.75[a]	0.56
MAT	0.02	0.01	0.18	0.03	0.01	0.02	0.10	0.01	0.01	0.01	0.35	0.12	0.02	0.02	0.39	0.15
Dribbling	0.07	0.03	0.25[a]	0.06	0.06	0.05	0.22	0.05	0.07	0.05	0.27	0.07	0.09	0.06	0.54	0.30

CMJ: Countermovement jump test; MAT: Modified agility T-test; SE: standard error.
[a] Statistical difference ($P < 0.05$).

anaerobic tests between sport classes in CP football [9]. The results from this study showed statistical differences in the physical performance according to the players' sport classes, favouring players with less physical impairment (FT2 and FT3) compared to players with high level of impairment (FT1). These differences between sport classes are in line with previous studies which reported that players with higher activity limitation are those with worse performance in the vertical jump [28], sprint and acceleration function [6], and change of direction ability with and without the ball [7]. However, physical performance between FT2 and FT3 did not show differences (excluding the CMJ). It is possible that players with FT2 (medium level of impairment) do not exhibit major problems in forward and sidestep displacements and, considering that there is an overrepresentation of para-athletes with unilateral spasticity, they could be using motor strategies to mask the impact of the impairment in those physical actions [4,7].

On the other hand, no statistical differences were obtained comparing the players' physical performance across age groups. Both, Pearson's correlation and regression analyses showed a relationship between the age of the participants and their performance in the 20-m sprint (only within the FT3 class) and the dribbling test (for the overall sample). The comparison between age groups within each sport class suggests that the lack of differences between age groups was not influenced by the functional profile. These results are consistent with what has been reported by Haugen et al. [29], who compared sprint and CMJ performance among non-impaired female footballers, showing a performance that remained stable over time. Similar patterns of results have been shown by the literature in other variables which are not included in the present study (i.e. aerobic capacity) but in which no significant differences were found between age groups [30]. Contrary to this, earlier studies explored the effect of age on the CMJ of able-bodied male football players and they showed that players from older age groups presented higher performance values due to gains in leg muscle power and free fat mass [16,31].

The change of direction ability is considered as a relevant multifactorial fitness attribute of team sports [32]. Specifically, in CP football, Henriquez et al. observed a significant relationship between the change of direction ability and the repeated sprint ability. In addition to this, the change of direction ability has been shown as a discriminant variable for players from different sport classes [7,33]. Contrary to the findings of Fiorilli et al., who reported differences in change of direction ability between able-bodied players from 12 to 18 years old, no differences were reported in the change of direction ability across the different age groups in the present study.

It is well known that the aging process has an impact on physical and mental development, taking into account that the age of peak performance may differ between sports or competitive events [18]. Contrary to what was described in able-bodied football players aged > 30 years, who presented a lower physical performance compared to younger ager groups (13—15), the present results seem to suggest that age does not influence components such as vertical jump, sprint capacity, change of direction ability and dribbling. Possibly, the absence of differences between age groups could be due to less and later access to sport participation in para-athletes, for who rehabilitation therapies are an important part of children and adolescents' lives, and the transition between traditional rehabilitation and community-based sports activity programs could influence the competitive development process [34,35]. A prior research in elite youth players without disability suggests that for talent identification is necessary to consider maturity status and performance variables as tactical position-specific, reinforcing the multifactorial nature of the sport and opening the door to explore this aspect in players with CP [36]. In this sense, insufficient and/or inadequate long-term training programs once they are enrolled in CP football participation could be a reason for the lack of development in physical performance across ages. Further research is necessary focusing on how CP football players may benefit from a systematic long-term training program and to determine if physiological factors (i.e., endocrine markers) could be related to performance as was previously reported [37].

Besides, CP football competitions (in most of countries as well as internationally) do not have different age categories because there is not a big enough pool of participants to create different groups inside clubs and academies. The only rule about age in these competitions is a minimum age of 15 years old to participate. Regarding physical performance, the present findings suggest that CP footballers from 15 to 53 years can train and compete together without the need to create age groups. However, this informa-

tion should be interpreted with caution because players present a great impairment variability with specific activity limitations, emphasizing the individualization of the sports development process.

Another feature to take into account in adults with CP includes early declines in motor function, which may start earlier than adulthood, conditioned by a potential mechanism associated with the secondary consequences of the primary neurological insult with an accelerated progression of muscle pathology [38,39]. The non-significant differences between age groups could reflect the benefit from the systematic sport participation on the evaluated player's physical fitness, although further research is needed to confirm the effect of football practice in the prevention of long-term health risks in football players with CP [34].

Although the participants of this study correspond to a representative sample of the Spanish CP football league, it only represents the local reality, limiting the generalizability to the larger CP para-footballer population. Future studies should consider the possibility of analysing the age effects in longitudinal protocols, considering the game position and the physical match performance of international para-footballers with CP. In addition, further research is needed to deeper the understanding of the control of the training [40], well-being [41], and the variations during the competitive season [42], necessary to maximize the development and prevent injuries of young para-footballers with CP.

The results of this study may show some practical applications that could be considered in CP football practical field. First, regarding the rules of international championships, this study supports the idea that 15-years-old players have the physical performance requirements to compete in these international championships together with senior players. In addition to this, the sport class of the participants do not influence these results, so it is generalizable to each sport class. These findings may help coaches of international teams in their talent identification and selection process, having the opportunity to select younger players without harming the physical performance of the team, and ensuring that these younger players receive specialized training earlier, increasing their sport performance potential.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgements

The authors would like to thank the Spanish Sports Federation of People with Cerebral Palsy (FEDPC) for its collaboration in the present study.

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