Rev Bras Cineantropom Desempenho Hum
original article
https://doi.org/10.1590/1980-0037.2024v26e86948

Anthropometrical features of cerebral palsy football players according to their impairment classification and playing position

Características antropométricas de jogadores de futebol com paralisia cerebral de acordo com sua classificação funcional e posição de jogo

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Abstract – CP football is played by male athletes with cerebral palsy, with rules similar to soccer, with some adaptations, but with the same demands for results and motor performance. Therefore, the objective of this study was to identify and analyze the anthropometric profile, body composition, somatotype, and motor performance of CP Football athletes, according to the impairment topography, sport class and game position. Thirty-seven athletes from the Brazilian CP football team participated in the study, who had body mass, height, circumference, bone diameters, skinfold thickness, and agility, speed and aerobic capacity VO2max tests. The motor performance of CP football athletes, in speed and aerobic capacity tests were significantly different (p<0.05) according to the impairment topography. Significant correlations were found between the impairment topography and sport classes for the variable's agility (r= 0.39 and r= -0.40), 30m speed (r= 0.50 and r= -0.48) and the aerobic capacity VO2 max (r= -0.39 and r= 0.62). This study presents indications that the anthropometric, body composition and somatotype variables do not differ according to the impairment topography, functional class and game position in CP football athletes. Such findings can be guiding for the teams of the modality, as they differ from the conventional sport.

Key words: Anthropometry; Cerebral palsy; Para-athletes.

Resumo – *O futebol PC é praticado por atletas homens com paralisia cerebral, com regras parecidas com o futebol convencional, com algumas adaptações, porém com as mesmas cobranças de resultado e desempenho motor. Por isso, o objetivo deste estudo foi identificar e analisar o perfil antropométrico, da composição corporal, do somatotipo, e da performance motora de atletas de futebol PC, de acordo com a topografia da deficiência, classe esportiva e posição de jogo. Participaram trinta e sete atletas da seleção brasileira de futebol PC que tiveram massa corporal, estatura, circunferência, diâmetros ósseos, espessura de pregas cutâneas, e testes de agilidade, velocidade e capacidade aeróbia VO2máx. A performance motora dos atletas de futebol PC, nos testes de velocidade e capacidade aeróbia foram significativamente diferentes (p<0,05) de acordo com a topografia da deficiência. Correlações significativas foram encontradas entre a topografia da deficiência e classes esportivas para as variáveis agilidade (r= 0,39 e r= -0,40), velocidade 30m (r= 0,50 e r= -0,48) e o capacidade aeróbia VO2 máx (r= -0,39 e r= 0,62). Este estudo apresenta indicativos de que as variáveis antropométricas, da composição corporal e somatotipo não diferem de acordo com a topografia da deficiência, classe funcional e posição de jogo em atletas de futebol PC. Tais achados podem ser norteadores para as equipes da modalidade, pois diferem do esporte convencional.*

Palavras-chave: *Antropometria; Paralisia cerebral; Paratletas.*

Received: April 10, 2022
Accepted: July 16, 2024

How to cite this article
Borges M, Faria FR, Buratti JR, Vieira AB, Sá KSG, Vieira IB, Nogueira CD, Costa e Silva AA, Gorla JI. Anthropometrical features of cerebral palsy football players according to their impairment classification and playing position. Rev Bras Cineantropom Desempenho Hum 2024, 26:e86948 DOI: https://doi.org/10.1590/1980-0037.2024v26e86948

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INTRODUCTION

In the last decades, physical activity and sports practices have undergone several changes regarding the physical demands imposed on athletes. In soccer, there are specific demands and functions within the team that must be considered in training and the same occurs in cerebral palsy (CP) football.

CP Football is a modality intended for people with CP, in addition to individuals who have sequelae of traumatic brain injury or stroke[1]. The modality can be characterized as intermittent just like soccer, which alternates high and low intensity efforts and short recovery periods[2,3]. Each team is composed of seven players, a goalkeeper and six outfield players who are distributed in the attack, midfield and defense playing position.

In addition to the playing positions on the field in this modality, athletes have a sport classes (FT1, FT2 and FT3), which brings important indications of the possibilities and motor limitations directly related to sports performance[4].

According to Bompa[5] training prepares the athlete globally, through positive adaptations, in order to maximize the effects of the stimulus, in order to allow the athlete to optimize, reaching the highest possible level in performance.

In this sense, for the preparation of the CP Football athlete, in addition to the specifics of the position on the field, sport class and the specificity of the impairment, it is necessary to consider the anthropometric variables, body composition and somatotype that may also contribute to sports performance. Since anthropometric measurements and body composition are indicative of the athlete's current physical condition and their monitoring allows adjustments in training planning[6]. On the other hand, the somatotype technique allows detecting and determining the shape, structure and composition of the human body and establishes a resource for analyzing body changes due to training and physical demands according to the sport[7].

However, studies with CP Football athletes have not yet brought any indication that there is a correlation between motor tests and anthropometric variables, body composition and somatotype, and whether the impairment topography influences sports performance. Thus, the present study aims to: (1) identify and analyze the anthropometric profile, body composition and somatotype of CP Football athletes according to impairment topography, sport class and game position; (2) describe and analyze the motor performance of these players according to impairment topography, sport class and playing position; (3) to analyze the relationship between the impairment topography, sport class, playing position, anthropometric measurements, body composition and somatotype profile with the motor performance of CP Football athletes.

METHODS

A cross-sectional study was conducted in thirty-seven male athletes (24.8±6.1years) from the CP-Football Brazilian Team (main and under-19 teams) with a valid license from the National Association of Sports for Disabled (ANDE, in Portuguese). The athletes during the training and evaluation phases in the season 2018-2019. Participants were classified according to impairment topography (hemiparetic, global and diparesis), by sport classes (FT1, FT2 and FT3) following the classification rules and regulations of the International Federation of CP Football[1] and by playing position (midfield, defender, forward and goalkeeper). Before the data collection, individual player informed consent was obtained, and a documentation of understanding was signed by each athlete to ensure robust comprehension of the expectations of study participation. The study was approved by the Institution's Research Ethics Committee of the Faculty of Medical Sciences of the State University of Campinas, under registration number 3.491.940, and performed in agreement with the WMA Declaration of Helsinki.

The anthropometric characteristics analyzed were collected by a trained researcher responsible for all anthropometric measurements according to a standardized protocol. Height was measured to the nearest 0.1 cm, using a wall stadiometer (Wiso, Cardiomed Ltd., Curitiba) and body mass was measured to the nearest 0.1 g, using the air-displacement plethysmography (ADP) scale. The Body Mass Index (BMI) was calculated by dividing body weight (in kilograms) by squared height (in meters).

To obtain the information on body fat percentage, percentage of fat free mass, fat mass (kg) and fat free mass (kg), a method considered standard, ADP (BOD PODTM, COSMED INC; Concord, CA, USA) was used. Before data collection procedures for each athlete, the device was calibrated using a cylinder of known volume (50,056 L). With the body mass and volume obtained in the ADP, the researchers calculated the body density of each participant, which was later converted into a percentage of body fat and fat free mass using the equation[8].

The Heath-Carter Anthropometric Somatotype[7] was used to determine the body types. The Heath-Carter method consists of 10 anthropometric measurements including height, weight, arm width (i.e., the width of the humerus in the elbow area), hip width (i.e., the femur width in the knee), maximum arm circumference, maximum calf circumference, subcutaneous fat in triceps, subscapularis muscle, supraspinatus muscle, and gastrocnemius muscle of individual participants. In order to measure the level of subcutaneous fat, was measured to the nearest 0.1 mm with Harpenden™ caliper (Marsden UK British Indicators Ltd, London). The study considered the mean of two consecutive measurements for each anthropometric variable. A third measurement was carried out when the average value between the first two measures was greater than 0.5 mm. The Heath-Carter method gives three endomorphic, mesomorphic, and ectomorphic scores to each individual, and the one with one and a half points higher than other scores, considered being the body type of that person.

Skills tests

Yoyo Intermittent Recovery Test (Yo-Yo IRTL1)

The Yo-Yo IRTL1[9] was administered on a field similar to that of the sport. The athletes were instructed and familiarized with the test realization. They consists of bi-directional runs of 2 x 20 m interposed with active recovery of 10 s (2 x 5 meters walking) every 40 m, with speed increase at each stage, the test is controlled by an audio. The total accumulated distance in meters of each athlete was recorded. For the indirect calculation of VO^2máx was used the following equations: Yo-Yo IR1 test: VO^2max (mL / min / kg) = IR1 distance (m) × 0.0084 + 36.4[9].

Modified Illinois CODS test

The modified Illinois CODS test[10] it is configured with cones forming the agility area, in which the athlete must perform alternating sprints and changes of direction in markers. They were instructed to complete the test as quickly as possible and not to cut over the markers but to run around them. In case of an execution error, the test was interrupted and a new attempt was made after the recovery period.

Speed test of 10 and 30 meters

The objective was to evaluate the speed of to move in the same direction for a 30 meters course, starting from the stationary position. Two runs were carried out, with 3 minutes of recovery, in a football field with natural grass. The time of the first 10 meters and the total travel time of 30 meters in seconds were recorded.

Data analysis

The study assessed normality by using Shapiro-Wilk test, describing data as their mean and standard deviation (±SD). Next, the following comparisons was applied the Mann Whitney test. For the correlation Spearman's test was used. The qualitative thresholds used to assess the correlations were: <0,1: trivial; 0,1-0,3: small; 0,3-0,5: moderate; 0,5-0,7: large; 0,7-0,9: very large; > 0,9: nearly perfect[11]. The SPSS software for Windows version 21 was used. The level of significance adopted for all analyzes was $p \leq 0.05$.

RESULTS

Anthropometric and body composition variables do not differ according to sport class or playing position (Table 1). There was only a statistically significant difference ($p<0.05$) for the height variable according to the impairment topography.

Table 1. Sample characteristics according to sport class and position.

	Age (years)	BM (kg)	Height (cm)	BMI (Kg/m^2)	BF (%)	LM (%)
Impairment topography						
Hemiparetic (n=26)	24±5	71.4±9.0	176±5.0*	23.0±2.4	15.0±6.2	85.0±6.2
Global[a] (n=6)	29±8	69.7±12.4	173±8.9	23.2±3.3	12.8±4.8	88.2±2.5
Diparesis (n=5)	23±5	67.2±8	169±5.1	23.7±3	11.2±3.4	88.8±3.4
Sports class						
FT1 (n=5)	27±8	68.1±11	171±10	23.2±3.1	11.92±4.9	88.1±4.9
FT2 (n=20)	25±6	71±10.7	175±5.7	23.2±3	14.6±6.5	85.4±6.5
FT3 (n=12)	24±5	70.9±6.4	176±5.3	22.9±1.8	14.35±4.9	85.6±4.9
Position						
Forward (n=7)	25±9	68.9±12.6	170±9	23.6±3.3	13.4±5.3	87±5.3
Midfield (n=14)	24±4	69.2±7.8	174±4.5	22.8±1.8	13±5.2	87±5.2
Defender (n=9)	23±6	67.9±3.2	176±6.1	22±1.8	13±4	87±4
Goalkeeper (n=7)	29±6	78.3±11.4	179±2.6	24.4±3.7	19±7.6	81±7.63
Group	25.1±6	70.6±9.3	174±6.2	23.1±2.6	14.1±5.7	85.8±5.7

Note. [a]Global: this terminology refers to athletes who have Dystonia/Athetosis where there is no way to define a specific topographic area, that is, these characteristics that can act on all musculatures. BM = Body mass. BMI = Body Mass Index. BF= Body Fat Percentage. LM= Lean Mass Percentage. *Hemiparetic vs Diparesis, p< 0.05.

When analyzing the semitopological variables, was verified that the group presents a Mesomorph-endomorph classification, with no statistically significant differences according to impaiment topography, sport class and game position (Table 2).

Table 2. Mean ± SDs of somatotype data according to sports class and position.

	Endo	Meso	Ecto	Classification
Impairment topography				
Hemiparetic (n=26)	3.43±1.42	3.42±1.10	2.61±1.09	Endomorphic mesomorph
Global (n=6)	3.84±1.86	3.68±1.30	2.40±1.38	Endomorphic mesomorph
Diparesis (n=5)	2.91±0.84	3.52±2.17	1.95±1.38	Endomesomorfo
Sports class				
FT1 (n=5)	3.34±1.52	3.94±1.37	2.30±1.47	Endomesomorfo
FT2 (n=20)	3.57±1.54	3.28±1.37	2.49±1.25	Endomorphic mesomorph
FT3 (n=12)	3.23±1.25	3.61±1.06	2.54±0.93	Endomorphic mesomorph
Position				
Forward (n=7)	3.61±1.57	3.96±1.33	2.09±1.31	Endomorphic mesomorph
Midfield (n=14)	2.92±1.04	3.05±1.29	2.47±0.70	Endomorphic mesomorph
Defender (n=9)	3.10±1.02	3.35±1.25	2.98±1.13	Central
Goalkeeper (n=7)	4.68±1.80	4.02±1.02	2.28±1.72	Mesoendomorfo
Group	3.36±1.45	3.48±1.26	2.60±1.20	Endomorphic mesomorph

Endo = Endomorph. Meso = Mesomorph. Ecto = Ectomorph. FT1, FT2 and FT3 = sports classes; Group: all participants.

Considering the impairment topography, in the motor performance tests the athletes with global impairment topography (Dystonia/Athetosis) obtained the worst results in most of the proposed tests. When analyzing the performance in motor tests by sport class, the worst results were achieved in the FT1 class (which have greater impairment) being significantly higher than the results presented by the FT2 and FT3 classes in the 10m speed test ($p<0.05$) and 30m ($p<0.05$). Differences in some tests considering the position, and the goalkeepers were the ones who obtained the worst results (Table 3).

Table 3. Motor tests according to impairment topography, sport classes and playing position.

	Illinois (s)	Speed 10m (s)	Speed 30m (s)	$VO_{2máx}$ (mL/Kg/min)
	(n=37)	(n=28)	(n=28)	(n=37)
Impairment topography				
Hemiparetic	12.1±0.9	1.7±0.3	4.5±0.4[a]	41.8±2.1[b]
Global	13±1.2	2±0.2	5.5±1.4	39±1.8
Diparesis	13.3±2.2	1.9±0.4	5±0.6	40.8±3.4
Sports class				
FT1	13.4±2.3	2.1±0.3c	5.7±1.5[c]	38.7±2.1c
FT2	12.4±0.9	1.8±0.3d	4.7±0.4	40.9±2.3[d]
FT3	11.6±0.6	1.5±0.2	4.3±0.3	43.3±1.7
Position				
Forward	12.6±2	1.9±0	4.9±0.7	40.4±2.1
Midfield	11.8±0.6	1.7±0.3	4.5±0.3	42.4±2.6[f]
Defender	12.1±1.1	1.6±0.2[e]	4.7±0.6	42.2±2.4
Goalkeeper	13.1±1.2	2.1±0.2	5.4±1.5	39.4±1.6
Group	12.3±1.2	1.8±0.3	4.8±0.8	41.4±2.5

Note. [a]Hemiparetic vs Global, p=0.05. [b]Hemiparetic vs Global, p=0.02. [c]FT1 vs FT3, p<0.05. [d]FT2 vs FT3, p<0.05. [e]Defender vs Goalkeeper, p=0.02. [f]Midfield vs Goalkeeper, p=0.05. $VO_{2\,máx}$ = maximal oxygen uptake.

The impairment topography and the Illinois and speed tests showed a moderate positive and significant correlation with the impairment topography, indicating that athletes who have an impairment topography characterized by greater impairment of the lower limbs such as diparesis will have worse results especially in the 30m speed test. In relation to sport class, we observed strong and negative correlations with performance in the Illinois, speed 10m and 30m tests, which indicates that the lower the score of the sport class, the greater the time spent to perform these tests (Table 4). In addition, the sport class was positively correlated with the VO2max (r= 0.62 p=0.000) indicating that the higher the score in the sport class, the better the performance in these variables. It is also worth noting the moderate correlation of impairment topography with the 30m test (r=052; p<0.01) indicating the interference of this variable in longer sprints.

Table 4. Correlations between sport class, playing position, anthropometric features, body composition and somatotype profile with motor performance.

	Illinois (s)	Speed 10m (s)	Speed 30m (s)	$VO_{2máx}$
Topography	0.39*	0.31	0.50**	-0.39*
CE	-0.40*	-0.60**	-0.48**	0.62**
Positions	0.22	-0.05	0.16	-0.14
BM (Kg)	0.03	0.14	-0.07	-0.08
BMI (Kg/m2)	-0.02	0.08	-0.09	-0.09
BF (%)	-0.07	-0.03	-0.14	-0.13
LM (%)	0.07	0.03	0.14	0.13
Endomorphic	0.09	0.01	0.06	-0.29
Mesomorphic	-0.1	0.12	-0.16	-0.09
Ectomorphic	0.02	-0.11	0.04	0.13

Note. $VO_{2\,máx}$ = maximal oxygen uptake. CE = sports class. BM = Body mass. BMI = Body Mass Index; BF= Body Fat Percentage. LM= Lean Mass Percentage. *The correlation is significant at the 0.05. **The correlation is significant at the level 0.01.

DISCUSSION

Through the results we can identify that: 1) anthropometric measurements, body composition and somatotype do not differ according to topography, sport class and game position; 2) Sport performance results differ significantly according to topography, sport class and playing position; 3) Topography and sport class seem to be related to performance in motor tests.

Sports performance is the result of several processes and internal and external factors of the individual, that is, to achieve the desired sports performance we must consider the biological, psychological and social aspects of the individual[12] Anthropometric and body composition variables make up the biological aspects of the individual which in conventional football differ according to game position, category and game level[13]. These measures in soccer are used in conjunction with fitness measures to target athletes' physical preparation and monitor the effects of training on its components[14].

In this study, no significant differences in the anthropometric profile and body composition according to the playing position. However, goalkeepers had greater body mass, height, BMI, and %F compared to the other positions, which is in line with studies with young professional athletes, adult amateur, semi-professional and non-disabled professional soccer players[15-17]. This anthropometric profile was expected since these athletes have a lower metabolic energy expenditure in games and training[18].

As with the variables above, the anthropometric profile and body composition did not differ according to the sports classes, which corroborates the finding in another study[19]. In another study[20], the variables body mass, height, and BMI in different CP profiles (Spastic Diplegia; Athetosis/Ataxia; Spastic Hemiplegia and Minimal Impairment) and showed no significant differences between the groups. In this way, we can infer that the deficiency is not a determining factor in the anthropometric measurements and in the body composition of these athletes, having as determinants a set of other factors, such as food and training load.

As for the somatotype profile, we can identify differences between studies with the same population of athletes with CP. In this study, the group presented an endomorphic-mesomorphic profile, in the study by Gorla et al.[19] the profile was meso-endomorphic and in the study by Roquetti Fernandes and Fernandes[21] the profile was balanced mesomorph. These differences in profiles may be related to the applied external stimulus, diets, exercises, and training techniques that modulate the anthropometric measurements and, consequently, the somatotype.

Although there are no statistical differences in the somatotypological components between the game positions, we observed a predominance of the endomorphic component in goalkeepers, unlike soccer goalkeepers, which have a predominance of the mesomorphic component[15,17,22]. We believe that this difference in profile is related to the degree of motor impairment of the athletes who occupy this position, which, together with the lower metabolic overload in games and training characteristic of the position, may explain this difference in profile.

When analyzing the motor performance according to the position in the field, we noticed that the goalkeepers present lower VO2max compared to the other positions, being significantly inferior to the results of the midfielders. This difference observed in soccer athletes[23,24], related to the lower physical demand of this position, which requires speed and explosive capacity of upper and lower limbs associated with agility and a good speed/reaction time[25].

The best results for performance according to the impairment topography were for athletes who have hemiparesis, that is, athletes present impairment on one side of the body[26]. The significant differences in the hemiparetic group compared to the global group expected since the athletes who make up this group have dystonia/athetosis characterized by involuntary movements that can affect the entire musculature of the body[27], which consequently negatively limits the motor actions required in the tests.

Considering the performance in the motor tests, the worst results in the FT1 class and in the positions in which this player profile is found (attackers and goalkeepers). FT1 class players having greater motor limitations resulting from hypertonia, dyskinesia, or ataxia[1]. During the execution of exercises or activities, players of this class may present increased muscle tone, lower ranges of motion, balance alteration, involuntary movements, uncoordinated movements, which can cause greater impacts on the performance of motor tests than players of other classes[1].

Related results for agility, acceleration and speed can be observed in studies by Reina et al.[28,29] and also in Henriquez et al.[4] for agility and aerobic test, which verified that players from lower classes had lower results compared to the other classes.

Cerebral palsy can be classified according to motor manifestation, muscle tone, motor function and topography[30]. As for the topography, we observed moderate correlations with motor performance, which emphasizes the importance of understanding and considering the characteristics of impairment, especially in sports training, also paying attention to the biological individuality of each athlete. Relationships between sport class and performance found, as in the study Henriquez et al.[4] indicating that the greater the motor impairment, the lower the performance in the tests.

As for the anthropometric, body composition and somatotype variables, a possible explanation for not finding strong and significant statistical correlations with motor performance is the small number of the sample and its homogeneity, which is also a limitation of the study.

CONCLUSION

Through this study we have indications that the anthropometric, semitopological and body composition profile is not influenced by the topography of the impairment, sport class and game position in CP Football athletes. In addition, we identified that motor performance differs in terms of topography, sport class and position on the field, being significantly related to topography and sport class of CP Football athletes.

These findings can be a guide for new coaches and physical trainers of the modality, as they bring indications that differ from conventional sport, especially regarding morphological components and their influences on motor performance. Novel studies can be developed with this theme analyzing new variables such as training volume and food.

ACKNOWLEDGEMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

The data collection was supported by the National Association of Sports for Disabled (ANDE, in Portuguese).

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – State University of Campinas and the protocol (no. 87162718.4.0000.5404) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: MB, IB, JG. Performed the experiments: MB, FRF, JRB. Analyzed the data: KSGS, AACS. Contributed reagents/materials/analysis tools: ABV, CDN. Wrote the paper: MB, FRF, JRB, ABV, KSGS, IBV, CDN, AACS, JIG.

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