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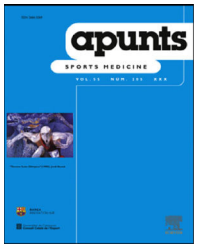

SPECIAL ARTICLE

Physical performance preparation for the cerebral palsy football world cup: A team study

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Abstract This study is the first study to show a cerebral palsy (CP) football physical performance preparation period for a World Cup. The physical performance improvement of fourteen international players belonging to the Spanish national team was assessed during five consecutive training camps (TCs) before the 2022 World Cup. The results revealed significant improvements ($t = 1.75-4.24$; $p < .05$) in the analysed variables between the first and the final TC, with changes ranging from 5.3% to 78.2% and effect sizes from 0.64 to 1.46 (moderate to large). All tests showed a consistent tendency to improve along the TCs and the pairwise analysis showed higher improvements in TC3 and TC5 compared to the values of TC1. This data could provide practical information to CP football coaches and practitioners since this is the first time that a physical performance preparation of a CP football team for a World Cup is studied.

Introduction

Cerebral palsy (CP) football is the adapted football modality played by athletes with CP or acquired brain injury. CP football is played by 7 players per team on a 70-m x 50-m pitch and during two halves of 30 min.[1] To play CP football, players should have a minimum impairment of hypertonia, athetosis or ataxia which impacts on the player's football abilities (i.e. coordination, balance or technical abilities). Once a player is eligible to play CP football, he is classified into three sport classes (severity of the impairment: FT1 > FT2 > FT3), which has implications for the game, as just one FT3 and a minimum of a FT1 player must play at the same time.

In the last few years there has been an increase in the scientific literature related to football players with CP. This indicates that CP football is undergoing a professionalization process and coaches and practitioners of this para-sport can benefit from scientific information about classification,[1–3] talent identification and selection processes, [4] physical demands of the game [5,6] and physical performance training and assessment.[7,8] CP football performance is determined by the player's ability to perform short and high-intensity actions together with periods of low-intensity actions.[5,6,9]

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Table 1 Descriptive data ($M \pm SD$) of the sample.

Sport class	n	Age (y)	Experience (y)	Weight (kg)	Height (m)	BMI ($kg \cdot m^{-2}$)
FT1	3	32.3 ± 11.0	7.7 ± 2.5	71.4 ± 15.9	1.73 ± 0.10	23.5 ± 3.0
FT2	11	26.7 ± 6.7	10.5 ± 4.8	67.2 ± 7.7	1.76 ± 0.07	21.6 ± 1.9
FT3	1	22	16	62.0	1.71	21.2
Total	15	27.5 ± 7.6	10.3 ± 4.6	67.7 ± 9.2	1.75 ± 0.07	22.0 ± 2.1

M: mean; SD: standard deviation; n: sample; y: years; kg: kilograms; m: meters.

For this reason, physical performance assessment in CP football usually includes players' linear sprint performance, change of direction and dribbling abilities, and intermittent endurance capability.[4,10]

The International Federation of Cerebral Palsy Football (IFCPF) World Cup is the most important international championship in which the 16 best-ranked national teams compete. National teams started to train after the restrictions imposed by their governments due to the Covid-19 pandemic to prepare for the 2022 IFCPF World Cup, and therefore the preparation period for this championship was different for the participants compare to their regular preparation. To the authors' knowledge, there is no previous literature that shows CP football national teams' preparation for an international championship, showing the players' physical performance improvements from the start of the preparation period to the last training camp before the championship. Thus, the aim of this study was to show the physical performance status of the Spanish CP football national team from the start (March 2021) to the end (April 2022) of its preparation period for the 2022 IFCPF World Cup.

Presentation of the case

Study design

This is an experimental case study, developed in an ecological environment, in which selected players for an international team (Spanish national team) were periodically evaluated to know their physical performance development before their participation in the 2022 IFCPF World Cup.

Participants

The Spanish national team count with a pool of 20 preselected players of which just 14 of them could be called for each training camp. The players' selection for attending to each training camp is carried out by the technical staff, based on technical criteria.

The player's inclusion criteria for this study was to have participated in at least 3 of the 5 training camps. 15 players were finally included in the study. All these players were federated in the Spanish Sports Federation of People with Cerebral Palsy, they competed in the Spanish CP Football National League with their usual teams and they were free of injury during the intervention of this study. This study was approved by an ethical committee (Ref: AUT.DCD. IPG.01.22), and players signed an informed consent according to the Declaration of Helsinki (2013).

Table 1 presents the sample information regarding the age, experience, anthropometrical data and level of impairment.

Study protocol

The Spanish CP football national team carried out 5 training camps (TCs) to prepare for the 2022 IFCPF World Cup

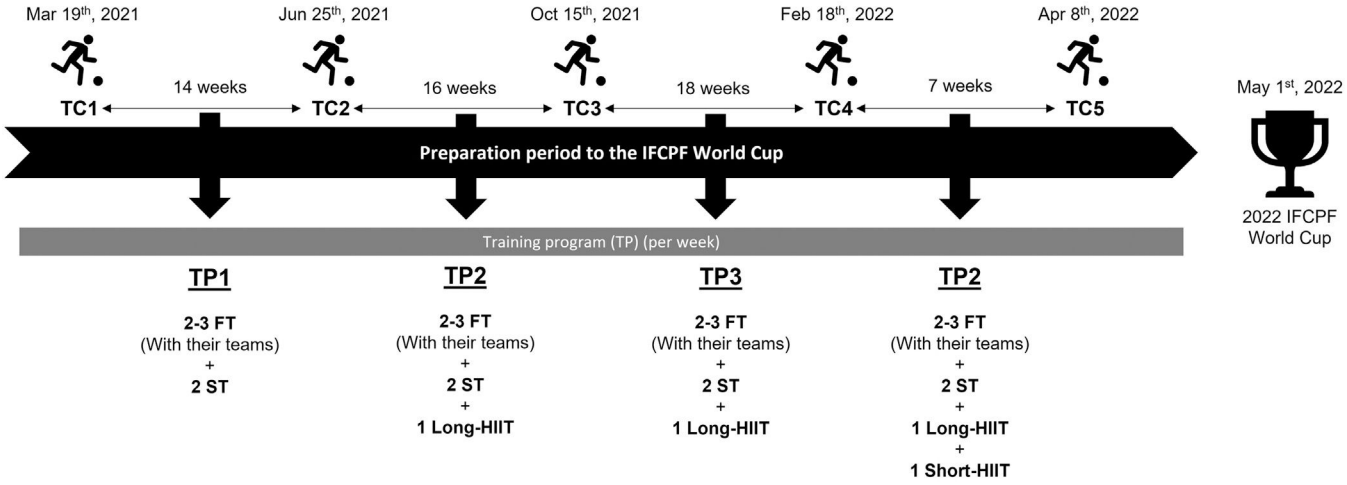

Fig. 1 Preparation period for the 2022 IFCPF World Cup, including the dates of TC and training programs between them. Mar: March; Jun: June; Oct: October; Feb: February; Apr: April; TC: training camp; IFCPF: International Federation of Cerebral Palsy Football; FT: football trainings; ST: strength training; HIIT: high-intensity interval training; RT: resistance training.

Table 2 Development of the self-training program.

TP1
Volume = 4 x 15 s/12rep (circuit) Intensity = Own weight Exercises = Frontal plank; Crunches; Hip thrust; Squat; Front lunge (R); Front lunge (L); Hip adduction; Push ups
TP2
2 ST sessions: Volume = 4 x 12rep Intensity = Own weight Exercises = Squat; Front lunge (R); Front lunge (L); Hip thrust; Ankle plantar-flex (R); Ankle plantar-flex (L) 1 Long-HIIT: Volume = 4 x 4 min (3 min rest: walking) Intensity = 70% vYIR1 Exercise = Running Circuit after session, 2 times per week: Volume = 4 x 15 s (circuit) Intensity = Own weight Exercises = Frontal plank; Lat plank (R); Lat plank (L); Back plank; Crunch; Push-ups
TP3
2 ST sessions: Volume = 4 x 12rep Intensity = Own weight Exercises = Squat; Front lunge (R); Front lunge (L); Hip thrust; Ankle plantar-flex (R); Ankle plantar-flex (L) 1 Long-HIIT: Volume = 10 x 2 min (1 min rest: walking) Intensity = 80% vYIR1 Exercise = Running Circuit after session, 2 times per week: Volume = 4 x 15 s (circuit) Intensity = Own weight Exercises = Frontal plank; Lat plank (R); Lat plank (L); Back plank; Crunch; Push-ups
TP4
1 ST session: Volume = 4 x 30s:15 s (work:rest) (circuit) Intensity = Own weight Exercises = Front lunge (R); Front lunge (L); Side lunge (R); Side lunge (L); CMJs; High skip; Ski lateral jumps; Jumping jacks. 1RT session: Volume = 3 x 10rep Intensity = 10(15) Exercises = Squat; Leg-ext; Leg-curl; Ankle plantar-flex; Press bench; Lat pulldown; Shoulder press. 1 Long-HIIT: Volume = 2 x 10 x 1 min (30 s rest: walking/2 min rest) Intensity = 90% vYIR1 Exercise = Running 1 Short-HIIT: Volume = 2 x 8 x 30 s (15 s rest: walking) Intensity = 100% vYIR1 Exercise = Running Circuit after session, 2 times per week: Volume = 4 x 15 s (circuit) Intensity = Own weight Exercises = Frontal plank; Lat plank (R); Lat plank (L); Back plank; Crunch; Push-ups

TP1: Training period 1 (between TC1 and TC2); TP2: Training period 2 (between TC2 and TC3); TP3: Training period 3 (between TC3 and TC4); TP4: Training period 4 (between TC4 and TC5); ST: strength training; RT: resistance training. vYIR1: velocity of the Yo-Yo IR1.

Table 3 Physical performance data (mean ± SD) for the initial (pre) and final (post) assessment including the percentage of change, *t*-test analysis and effect size.

Physical performance variables	TC1	TC5	% of change	t	*p*	ES (95% CI)
5-m sprint (s)	1.28 ± 0.14	1.18 ± 0.07	7.8	2.39	.012	−0.88 (−1.65; −0.10)
10-m sprint (s)	2.12 ± 0.21	1.98 ± 0.12	10.9	2.22	.017	−0.79 (−1.56; −0.03)
20-m sprint (s)	3.60 ± 0.35	3.41 ± 0.20	5.3	1.75	.045	−0.65 (−1.41; 0.11)
30-m sprint (s)	5.03 ± 0.53	4.75 ± 0.29	5.7	1.77	.044	−0.64 (−1.40; 0.12)
MAT (s)	6.68 ± 0.77	5.94 ± 0.30	11.1	3.27	.001	−1.23 (−2.04; −0.42)
Dribbling (s)	11.34 ± 2.37	8.95 ± 1.30	21.1	3.26	.001	−1.21 (−2.02; −0.41)
Yo-Yo IR1 (m)	642.35 ± 243.50	1144.60 ± 403.17	78.2	−4.24	<.001	1.46 (0.63; 2.30)

MAT: modified agility T-test; Yo-Yo IR1: Yo-Yo intermittent recovery 1; TC: training camp; ES: effect size in Hedges'g units; CI: confidence interval.

(Fig. 1). TCs lasted 3 days each one and were used to evaluate the players' physical performance (in the first session) and to train technical-tactical aspects. In the first session of each TC, players were evaluated for their acceleration and sprint abilities, their change of direction and dribbling abilities and their intermittent endurance capability. Between TCs, players carried out a self-training program, divided in 4 training periods (TP), and guided by the technical staff, which was updated after each TC. Table 2 shows the evolution of the prescribed physical training for each TP between TCs.

The self-training program prescribed was carried out by the players on their own during the periods between the TCs. Although the total duration of the training program was 55 weeks, it was divided into 4 periods (period 1: 14 weeks; period 2: 16 weeks; period 3: 18 weeks; period 4: 7 weeks) (Fig. 1). During the 4 periods, players performed the prescribed self-training together with their usual football-specific sessions with their usual teams (2−3 training sessions per week). These football-specific sessions were prescribed by the coaches of the player's usual teams and its aim was to develop technical-tactical competencies. For this reason, coaches were asked to not prescribe physical performance specific training for the players included in the pre-selected group. The prescribed training sessions (self-training sessions) could be performed by players as individual sessions or before their football-specific sessions (as part of them). These football-specific sessions were carried out in a synthetic grass pitch and players were also encouraged to perform the running-based sessions of the self-training program in the same surface.

Measures

All the tests used in this study have been previously validated and used with this population and presented good values for reliability. No modification or adaptations were needed to use these tests in this population.

Linear speed assessment: Players performed two attempts of a 30-m linear sprint in which time at 5, 10, 20 and 30-m was registered using photoelectric cells (Witty System, Microgate, Bolzano, Italy).

Change of direction ability: Players performed two attempts of the modified agility T-test (MAT) which was performed running in a forward direction during the whole test and without touching the cones, as reported by Arcos et al. (2020) and Peña-González et al. (2021).[4,11]

Dribbling ability: The same protocol as for the change of direction ability was used to assess the players' dribbling ability. In this case, players had to perform the test with the ball as reported by Peña-González et al. (2021).[4]

Intermittent endurance: Level 1 of the Yo-Yo Intermittent Recovery test (Yo-Yo IR1)[12] was used to assess the players' intermittent endurance.

Players performed two attempts of each test, except for the Yo-Yo IR1, with 2-min of recovery between each, and they were encouraged to perform them at their maximal effort. All the tests were performed on a synthetic grass field and players wore their usual soccer boots.

Statistical analysis

Data normality was confirmed by a Kolmogorov-Smirnov test. A *t*-test analysis for independent samples was used to compare the initial physical performance assessment (carried out in training camp 1) (TC1) with the physical performance data from the rest of the training camps. The effect size (ES) for these comparisons was estimated in Hedges' g units and interpreted as trivial (< 0.24), small (0.25−0.49), moderate (0.50−0.99), and large (> 1.00).[13] All calculations were performed using Microsoft Excel (Microsoft, Seattle, Washington, USA) and the level of statistical significance was set at $p < .05$.

Results

The *t*-test analysis showed significant differences between the initial (TC1) and the final (TC5) assessment (Table 3), indicating an improvement in 5, 10, 20 and 30-m sprint, the MAT, in dribbling and in the Yo-Yo IR1, with percentages of change from 5.3% to 78.2% and ES from 0.64 (moderate) to 1.46 (large). Pairwise comparisons between assessments in each training camp with the initial measurement (TC1) revealed improvement tendencies for all physical performance variables, highlighting improvements in the TC3 and the TC5, and with higher improvements in intermittent endurance (Yo-Yo IR1) (see Fig. 2).

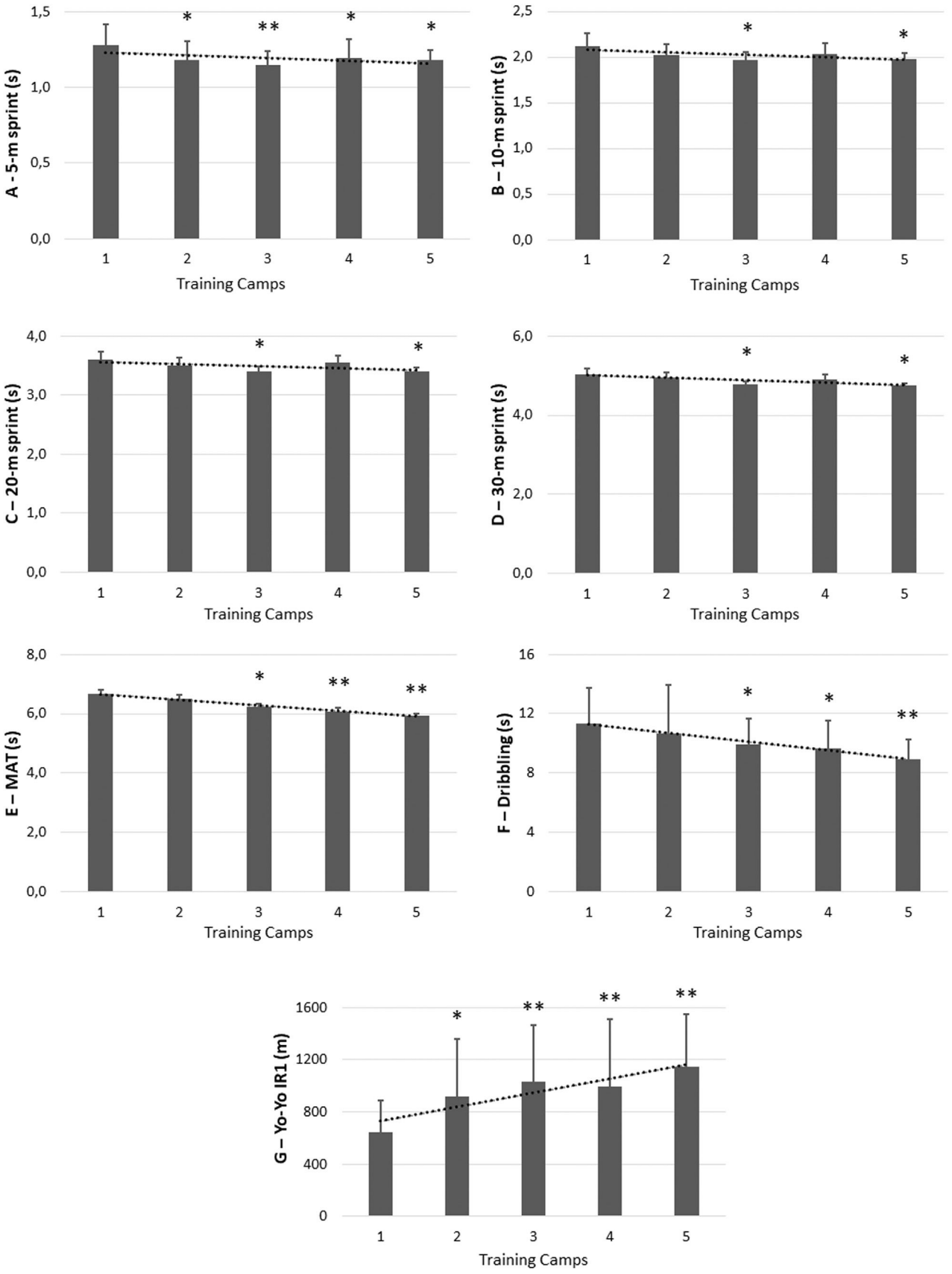

Fig. 2 Physical performance values (mean and SD) in the 5-m sprint (A), 10-m sprint (B), 20-m sprint (C), 30-m sprint (D), change of direction ability (E), dribbling ability (F) and intermittent endurance (G) for each TC with a trend line indicating the general trend of the data along the TC. MAT: modified agility T-test; * $p < .05$; ** $p < .01$Table 1. Descriptive data ($M \pm$ SD) of the sample.

Discussion

This is the first study that examined a CP football national team's physical performance preparation for the IFCPF World Cup. As a novel finding, this case study shows that the physical performance of this national team improved from 2001 to April 2022 with changes between 5.3% and 10.9% in linear sprint (5, 10, 20 and 30-m linear sprints), 11.1% and 21.1% in change of direction and dribbling abilities (MAT performed without and with ball), and 78.2% in intermittent endurance (Yo-Yo IR1 test).

Physical performance in CP football is determined by the player's ability to perform short, rapid and specific actions (i.e., accelerating, sprinting or changing of direction, among others), as well as to resist the repetitions of these high-intensity actions. In this regard, the training program proposed in this study was divided into 4 periods (separated by the TCs) in which strength-related and high-intensity interval training sessions were prescribed aiming to improve these short and high-intensity actions and the player's ability to reproduce them along the match with less fatigue. Although it has been shown that there is a lack of studies that show sport-specific physical performance adaptations to the training in CP athletes,[14] recent research have reported sport-specific physical performance adaptations (i.e., sprint or intermittent endurance) of international CP football players after a training period.[15]

The results of this study have shown *moderate* improvements in the team's sprint performance ($t = 1.75-2.39$; $p = .045-0.012$; ES = 0.64—0.88) and *large* improvements in change of direction ability ($t = 3.27$; $p = .001$; ES = 1.23), dribbling ability ($t = 3.26$; $p = .001$; ES = 1.21), and intermittent endurance ($t = 4.24$; $p < .001$; ES = 1.46). This indicates that the self-training program was effective to improve the physical performance of players belonging to the team. Although the total training program lasted 55 weeks, the training contents of each TP was updated after each TC, aiming to have a progressive adaptation to the training. Strength-based training used in this study has been previously shown as effective to improve CP football players physical performance,[15] but in this case, it was implemented with a progression in the load (manipulating volume and intensity between TP). The improvements in sprint and/or changing of direction (with or without ball) after a strength training program in combination with players' usual football training have been widely shown in able-bodied players.[16-18] Specifically, self-training programs similar to the presented in this study have been shown effective to maintain international CP football players' physical performance during a 12-week period in the COVID-19 lockdown,[7] or to improve players' acceleration, sprint and endurance during a 25-week period, in combination with football-specific training.[15]

The improvements reported for the intermittent endurance in this study (78.2%) were higher than for the other variables (5.3—21.1%). This fact indicates that the training program was effective to improve the players ability to reproduce high-intensity runs with short periods of recovery. This is in line with traditional results regarding the use of HIIT in football, especially for the improvement in intermittent endurance.[19-21] However, the high difference in the percentages of improvement regarding the rest of variables shown in this study, may indicates that other factors besides the aerobic or cardiovascular improvements are influencing these results. As reported Peña-González et al. (2023), the players' adaptations to the training program for sprinting or changing of direction, could be influencing the performance in the Yo-Yo IR1 test, since its protocol includes repeated accelerations and decelerations with changes of direction.[15] Therefore, it is necessary caution to interpret these results, as the high improvements in the Yo-Yo IR1 test could be given a sum of improvements in cardiovascular and neuromuscular parameters.

Regarding the changes in the team physical performance across the TCs, higher improvements were reported in the TC3 and the TC5 compared to the baseline (TC1). In these two periods there were significant increases and variations in the training program load, which could have benefitted players' adaptations. Although the TP between the TC4 and the TC5 was the shortest one, the increase in training intensity while the total volume was maintained or reduced (tapering strategy) could be the reason for the high physical performance values in the TC5. The lack of significant improvements in some tests in the TC2 could be explained by the low total volume of the first training period in comparison to the other periods. Although the training period between the TC3 and the TC4 was longer than the rest of the training periods, TC4 showed a lower adaptation to the training than other periods. A possible explanation for this fact is that players could have adapted to the training stimulus, as the training program was very similar to the previous training period. In addition, Christmas holidays during this training period could have impacted the player's adaptation process to the training negatively.

This study presented some limitations that should be taken into account to interpret the results. A repeated-measures or paired-samples *t*-test analyses would have been more adequate analyses for this study protocol, but these analyses were not possible as the players in each TC were not exactly the same. In addition, the players included in this study had a heterogeneous CP diagnosis (e.g., spastic diplegia, hemiplegia, athetosis or ataxia) and sport class (which indicates the severity of the player's impairment and the impact on the game). However, the type and/or severity of the player's impairment was not considered in the analysis as the small sample size did not allow a subdivision of the sample. Finally, there are some limitations regarding the training program, since the ecological environment in which the study was performed did not allow to the investigators to decide the dates of the TCs, and thus, the duration of the TP, as well as working from a distance with the players make more difficult the control of the training loads applied. This limitation was partially controlled by having weekly contact with the players, in which players reported the training loads performed.

Conclusion

This study showed the two-year planning of a CP football national team to prepare for the IFCPF World Cup. This intervention showed that the team improved its physical performance from 5.3% to 78.2% in the linear sprint, change of direction and dribbling abilities, and in intermittent endurance. Although there was a consistent tendency to improve all physical performance tests during the different TCs, the pairwise analysis showed higher improvements in TC3 and TC5. Data from this study could provide practical

information for CP football coaches, professionals and practitioners since this is the first time that a physical performance preparation of a CP football national team for a World Cup is studied.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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Confidentiality of data

The authors declare that they have followed the protocols of their work center on the publication of patient data.

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