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Time–Motion Characteristics and Physiological Responses of Para-Footballers With Cerebral Palsy in Two Small-Sided Games and a Simulated Game

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This study compared physical performance in a group of international cerebral palsy football players during two formats of small-sided games (SSGs) and performance in a simulated game (SG) according to players' sport classes (FT1, FT2, and FT3). Internal load (heart rate and rating of perceived exertion) and external load (total distance, distance covered at different velocities, maximum speed reached, acceleration, and deceleration) were obtained with global positioning system devices during two formats of SSGs (2-a-side/SSG2 and 4-a-side/SSG4) and an SG (7-a-side). SSG2 demands faster actions compared with SSG4/SG, and significant differences and large effect sizes were found in the distance covered in Speed Zones 5 (16.0–17.9 km/hr) and 6 (>18.0 km/hr; $p < .05$; $.35 < \eta_p^2 < .50$, large). Lower moderate accelerations and decelerations per minute in SSG4/SG compared with SSG2 were also found ($p < .01$; $.77 < \eta_p^2 < .81$, large). In the SSG2 task, the FT3 players reached maximum speeds, covered more distance at the highest intensities, and performed more moderate/high

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accelerations/decelerations and more sprints compared with FT1 and FT2 players ($p < .05$; $-0.85 < d_g < -4.64$, large). The SSG2 task could be the best option for discriminating physical demands in important variables for cerebral palsy football performance between classes FT3 versus FT1/FT2.

Keywords: brain injury, disability, para-sport, physical performance

Football, also known as soccer, is the most popular sport in the world, and it is practiced in different forms by people with and without disabilities (Stølen et al., 2005). Considering the different forms of football for people with disabilities, cerebral palsy (CP) football introduces some modifications in the rules (e.g., five substitutions, no offside) and the field dimensions (i.e., 70 × 50 m) to be played by para-athletes with eligible impairments of hypertonia, ataxia, or dyskinesia. Despite the adaptations included in this para-sport, a lot of training methods are used with CP Football players (CPFPs) to improve their physical condition, performance, and technical and tactical skills according to the game demands (Sarmento et al., 2018).

A popular training task used in football sessions involves different types of small-sided games (SSGs), which consist of modified field size and number of players playing compared with regular football (Hill-Haas et al., 2011). SSG has been widely popularized as a training form due to its capacity to replicate physical, technical, and tactical demands, similar to what occurs in official games (Dellal et al., 2011; Gabbett & Mulvey, 2008). More specifically, several studies have reported 2 versus 2, 3 versus 3, or 4 versus 4 SSGs to describe internal and external load values in regular football (Castellano et al., 2013; Dellal et al., 2012; Köklü et al., 2011; Köklü et al., 2012). Therefore, different forms of SSGs have demonstrated the influence of different factors that affect the intensity of the game (Hill-Haas et al., 2011; Sarmento et al., 2018). However, the number of players, the field dimensions, the level of competition, the duration of the game, the participation of goalkeepers, the inclusion of specific rules, or the coach/staff motivation are factors that could influence the activity response during a SSG (Castellano et al., 2013; Dellal et al., 2011; Gaudino et al., 2014; Hill-Haas et al., 2011; Köklü et al., 2012). Dellal et al. (2012) reported that 4 versus 4 SSGs replicate similar physical demands exposed in games of elite male football players. Although there are many studies in regular football about physical/physiological SSGs and game demands (Casamichana et al., 2012; Dellal et al., 2012; Gabbett & Mulvey, 2008), in CP football, game load has only been studied in real-game situations (Reina et al., 2020; Yanci et al., 2019; Yanci et al., 2018), so it is still unknown whether some formats of SSGs replicate the game demands of this team para-sport.

Previous studies about game load description in CP football were based on a four-sports classes classification system: FT5 (i.e., moderate spastic diplegia), FT6 (i.e., moderate athetosis/ataxia), FT7 (i.e., moderate spastic hemiplegia), and FT8 (mild forms of the aforementioned profiles; Reina et al., 2020; Yanci et al., 2018). Nevertheless, in 2018, a new classification system was introduced for this team para-sport (i.e., FT1, FT2, or FT3) based on the type and severity of the three eligible impairments (i.e., hypertonia, athetosis/dystonia, or ataxia) and how they affect the performance of specific motor and football skills (International Federation of Cerebral Palsy Football [IFCPF], 2018a). Currently, 2 versus 2

SSG is used during an athlete's classification process as part of their technical assessment (IFCPF, 2018a). However, the comparison of the performance of eligible CPFPs in SSG formats and simulation games remains unknown, and the following would be essential for classification: (a) to know which types of SSG better reproduce the demands of competitive CP football and (b) to offer the classifiers the best conditions to observe players' proficiency for decision making to allocate sports classes in this para-sport. In addition, the knowledge of the comparison performance in SSG and game simulation can also contribute to a better understanding of training in para-footballers with CP and other related neurological health conditions.

Consequently, the first aim of this study is to compare the physical performance (internal and external game loads) of CPFPs during two formats of SSGs (2-a-side and 4-a-side) and the performance in an SG (7-a-side). Second, this study also aims to describe physical performance across the new sports classes recently implemented in CP football. Hence, this study hypothesizes that smaller game dimensions and a lower number of players involved in the game demand higher physical responses in para-footballers with CP. Also, the study hypothesizes that para-footballers with lower impairment will exhibit better proficiency during the game.

Methods

Participants

Fourteen international CPFPs took part in this study, all of whom belonged to the Chilean CP football national team (age = 24.7 ± 5.5 years; height = 170.7 ± 5.6 cm; body mass = 64.6 ± 9.9 kg; body mass index = 22.2 ± 2.8 kg/m^2; CP football experience = 10.4 ± 3.0 years; training sessions per week = 4.8 ± 0.7). The participants were classified according to the classification rules of the International Federation of Cerebral Palsy Football (2018a), belonging to the three CP football sport classes: FT1 ($n = 6$), FT2 ($n = 5$), and FT3 ($n = 3$). Goalkeepers were excluded from the study, so only field players were invited to participate. Before involvement in the investigation, all participants gave their written informed consent after receiving a detailed written and oral explanation of the potential risks and benefits resulting from taking part in this study. The ethics committee of Diego Portales University, following the Declaration of Helsinki principles (2013), authorized the study (code 15-2018).

Measures

Internal Game Load. Heart rate (HR) was continuously monitored throughout the SSGs and the SG at 5-s intervals by telemetry (Polar T31 coded, Kempele, Finland). The two SSGs and the SG were reported for the analysis with the mean HR (HR_{mean}) and the maximum HR (HR_{peak}). The HR_{peak} was determined from the highest HR value from the SSGs and the SG. Also, the rating of perceived exertion (RPE) was recorded to assess the subjective intensity of the SSGs and the SG. Players responded separately to the 10-point scale (CR-10) at the end of the SSG and SG (Borg et al., 2010). Players were fully familiar with the CR-10 scale before data collection as these methods had been used previously.

External Game Load. Global positioning system (GPS) devices (SPI-HPU; GPSports Systems, Canberra, Australia) were also used during the SSGs and the SG, providing data for time–motion characteristics covered at a frequency of 15 Hz with reliability measured by a coefficient of variation of 0.9% for measuring high sprinting velocities and good interunit reliability for recording distances at velocities between walking and sprinting (coefficient of variation = 1.4–7.8%; Barr et al., 2019). The players used the manufacturer's jacket to locate the GPS device on their back, and data acquisition was monitored during the performance of the activity in the 2-a-side (SSG2), 4-a-side (SSG4), and SG tasks (Gaudino et al., 2014). Data were downloaded after the SSGs and the SG to a laptop and analyzed using a customized software package (SPI-IQ; GPSports Systems, Canberra, Australia). Several dependent variables were acquired throughout the GPS devices: total distance (TD, in meters per minute; Yanci et al., 2018) and the distance covered at different velocities, categorized in the following speed zones (Z): Z1 (0–6.9 km/hr), Z2 (7.0–9.9 km/hr), Z3 (10.0–12.9 km/hr), Z4 (13.0–15.9 km/hr), Z5 (16.0–17.9 km/hr), and Z6 (sprinting > 18.0 km/hr; Aguiar et al., 2013). Other variables were the maximum speed reached (Vel_{max}, km/hr; Casamichana et al., 2012) and four acceleration categories: high deceleration (−3 to −2 m/s^2), moderate deceleration (−2 to −1 m/s^2), moderate acceleration (1 to 2 m/s^2), and high acceleration (2 to 3 m/s^2; Osgnach et al., 2010). Considering that the duration of the training tasks was different (SSG2, SSG4, and SG), all variables were relativized, dividing the result of the variable obtained by the GPS by the real playing time of each player in the different game formats.

For all the measurements (i.e., HR as internal objective, RPE as internal subjective, and GPS external game loads), a total of 42 observations were included for data analyses (i.e., 3 tasks × 14 players).

Procedure

A cross-sectional study was conducted with three different measurement sessions 1 day apart from each other. On the first and second day, two different types of SSGs with two different groups in random order were played simultaneously (2 vs. 2 and 4 vs. 4) without specific rules so as not to influence the intensity in the game (Table 1). The players were familiarized with the SSG format before the

Table 1 Protocol Followed and Characteristics of the Different SSGs and the SG in Bout Duration, Number of Bouts, Duration Recovery, Pitch Area, and Pitch Ratio per Player

Activity	Duration (min)	Number of bouts	Duration recovery between SSGs (min)	Pitch area (m)	Pitch total area (m^2)	Pitch ratio per player (m^2)
2 vs. 2	2	6	2	12 × 24	288	1:72
4 vs. 4	4	6	2	24 × 36	864	1:108
SG	30	1	0	50 × 70	3,500	1:292

Note. SSG = small-sided game; SG = simulated game.

evaluation, and all participants performed the protocol during previous training sessions. Team selection for the SSGs took into consideration sports performance, position role, competition minutes, and coach perception in accordance with those referred to by Castellano et al. (2013). Along with this, classification was also considered, lining up in each team players of similar sport classes. On the third day, one halftime of an SG (30 min) was performed according to the international CP football rules (IFCPF, 2018b). All the evaluations were performed after 15 min of a standardized warm-up on an outdoor artificial grass field and at a similar hour of the day (Castellano et al., 2013).

The SSGs (i.e., SSG2 and SSG4) and the SG characteristics are described in Table 1, chosen according to a previous study by Köklü et al. (2011). For the SSGs and SG, participants were asked to put in the maximum effort during the task, and research staff encouragement was also given to the players in all the evaluations (Köklü et al., 2011). To avoid game stoppages, balls were placed around the pitch lines and entered immediately after the ball was played out. The SSG was played without a goalkeeper, with small goals (height = 0.90 m and width = 1 m) on synthetic grass.

Statistical Analysis

Standard statistical methods were used for calculating the mean and SDs. The distribution of each variable was verified by the Kolmogorov–Smirnov normality test. A 3 × 3 mixed analysis of variance was used to identify multiple comparisons between the different formats of training tasks (SSG2, SSG4, and SG) and to compare CP football sport classes (FT1, FT2, and FT3), introduced in the statistical model to assess the practical significance of within- and between-group differences, respectively. In both cases, the analysis was followed by a Bonferroni's post hoc test to explore pair comparisons. Two effect size indexes were used to assess the practical signification of within- and between-group differences. On the one hand, partial eta-squared (η_p^2) values were calculated as a measure of effect size for mean differences with the following interpretation: above 0.26, between 0.26 and 0.02, and lower than 0.02 were considered as large, medium, and small, respectively (Pierce et al., 2004). On the other hand, to calculate the effect size for pair comparisons, Hedges' g index was used (Hedges & Olkin, 1985). This index is based on Cohen's d index (Cohen, 1988), but it provides an effect size estimation reducing the bias caused by small samples ($n < 20$). Interpretation of Hedge's g was: >0.8, between 0.5 and 0.8, between 0.2 and 0.5, and <0.2 were considered large, moderate, small, and trivial, respectively. Data analyses were performed using the Statistical Package for Social Sciences for Windows (version 24.0; SPSS Inc., Chicago, IL). Statistical significance was set at $p < .05$.

Results

Comparison of Game Situations

The para-footballers' performance in the two modalities of SSG and the SG are presented in Table 2. With regard to the physiological demands (i.e., internal load), no significant differences were obtained for the HR measurements, whereas

Table 2 Internal and External Load of Football Players With Cerebral Palsy According to the Different Game Tasks

Internal- or external-load variable	Descriptive scores ($M \pm SD$)					Pair comparisons and effect sizes [LBCI, UBCI]		
	SSG2	SSG4	SG	p	η_p^2	SSG2 vs. SSG4	SSG2 vs. SG	SSG4 vs. SG
Physiological demands								
Heart rate mean	159.73 ± 11.80	165.45 ± 10.59	159.36 ± 13.54	.823	.007	−0.46 [−1.06, 0.15]	0.03 [−0.54, 0.60]	0.54 [−0.08, 1.16]
Heart rate peak	191.27 ± 5.41	197.27 ± 9.42	189.82 ± 13.33	.652	.027	−1.04 [−1.78, −0.31]	0.25 [−0.33, 0.83]	0.74 [0.08, 1.40]
RPE	7.09 ± 1.38	5.27 ± 2.24	5.82 ± 1.17	.068	.358	1.24 [0.44, 2.04]*	0.87 [0.18, 1.56]*	−0.23 [−0.81, 0.35]
Physical demands								
TD (m/min)	109.79 ± 11.13	105.47 ± 13.08	99.43 ± 9.48	.002	.593	0.36 [−0.23, 0.96]	0.88 [0.18, 1.57]**	0.43 [−0.17, 1.04]
Vel_{max} (km/hr)	20.01 ± 1.43	21.27 ± 2.17	22.59 ± 1.87	<.001	.703	−0.83 [−1.51, −0.15]*	−1.70 [−2.65, −0.74]**	−0.57 [−1.20, −0.06]*
Distance at different intensities (m/min)								
Z1 (< 6.9 km/hr)	14.30 ± 2.67	15.08 ± 2.65	14.70 ± 1.90	.638	.021	−0.28 [−0.86, 0.31]	−0.14 [−0.71, −0.43]	0.14 [−0.44, 0.71]
Z2 (7.0–9.9 km/hr)	49.73 ± 6.36	48.71 ± 6.76	41.56 ± 4.84	.002	.608	0.15 [−0.42, 0.72]	1.21 [0.42, 2.00]**	1.00 [0.27, 1.72]**
Z3 (10.0–12.9 km/hr)	35.58 ± 7.49	30.84 ± 9.25	30.41 ± 8.33	.037	.340	0.60 [−0.03, 1.22]	0.65 [0.01, 1.29]	0.04 [−0.53, 0.61]

(continued)

Table 2 (continued)

Internal- or external-load variable	Descriptive scores ($M \pm SD$)					Pair comparisons and effect sizes [LBCI, UBCI]		
	SSG2	SSG4	SG	*p*	η_p^2	SSG2 vs. SSG4	SSG2 vs. SG	SSG4 vs. SG
Z4 (13.0–15.9 km/hr)	8.73 ± 3.91	8.72 ± 3.88	9.64 ± 3.01	.444	.054	0.01 [–0.58, 0.57]	–0.22 [–0.80, 0.36]	–0.22 [–0.80, 0.36]
Z5 (16.0–17.9 km/hr)	1.36 ± 0.99	1.82 ± 1.27	2.47 ± 1.37	.032	.354	–0.44 [–1.04, 0.16]	–1.05 [–1.80, –0.31]*	–0.48 [–1.09, 0.13]
Z6 (> 18.0 km/hr)	0.09 ± 0.21	0.30 ± 0.51	0.64 ± 0.55	.007	.504	–0.94 [–1.65, –0.23]	–2.46 [–3.71, –1.21]*	–0.63 [–1.26, 0.01]
Short-term actions (number/min)								
High acc (2.0/3.0 m/s^2)	0.03 ± 0.05	0.02 ± 0.03	0.01 ± 0.02	.081	.251	0.19 [–0.39, 0.76]	0.38 [–0.22, 0.97]	0.31 [–0.27, 0.90]
Mod acc (1.0/2.0 m/s^2)	0.93 ± 0.58	0.55 ± 0.31	0.34 ± 0.15	<.001	.808	0.62 [–0.02, 1.25]**	0.96 [0.24, 1.67]**	0.64 [–0.01, 1.27]*
High dec (–3.0/–2.0 m/s^2)	0.13 ± 0.14	0.07 ± 0.09	0.07 ± 0.06	.069	.270	0.40 [–0.19, 1.00]	0.40 [–0.19, 1.00]	0.01 [–0.57, 0.57]
Mod dec (–2.0/–1.0 m/s^2)	0.79 ± 0.40	0.47 ± 0.18	0.32 ± 0.15	<.001	.772	0.75 [0.09, 1.42]**	1.11 [0.35, 1.86]**	0.78 [0.11, 1.45]**
Sprint count (number/min)	0.13 ± 0.12	0.19 ± 0.14	0.24 ± 0.14	.043	.322	–0.47 [–1.08, 0.14]	–0.86 [–1.55, –0.17]*	–0.34 [–0.92, 0.25]

Note. SSG2 = 2 versus 2 small-sided game; SSG4 = 4 versus 4 small-sided game; SG = simulated game; LBCI = lower bound confidence interval; UBCI = upper bound confidence interval; RPE = rating of perceived exertion; TD = total distance; Vel_{max} = maximum speed; Z = zone of intensity; mod = moderate; acc = acceleration; dec = deceleration.

*$p < .05$. **$p < .01$.

significant differences ($p < .05$) and large effect sizes were obtained in the pair comparisons between SSG2 versus SSG4 ($d_g = 0.86$) and SG ($d_g = 0.87$) for the RPE.

Overall significant differences and large effect sizes were obtained for the physical demands variables ($p < .01$; $.59 < \eta_p^2 < .70$). The TD covered was significantly lower in SSG2 than SG in the pairwise comparisons ($p < .01$; $d_g = 0.88$, large); in addition, significant differences and large effect sizes were found for the maximum speed reached, increasing the speeds from the SSG2 to the SG ($p < .05$; $-0.83 < d_g < -1.70$, large). Regarding the distance covered at different intensities, overall significant differences and large effect sizes were found in Z2 ($p < .01$; $\eta_p^2 = .61$, including SSG2/SSG4 vs. SG; $1.00 < d_g < 1.21$, large), Z5 ($p < .05$; $\eta_p^2 = .35$, including SSG2 vs. SG; $d_g = -1.05$, large), and Z6 ($p < .01$; $\eta_p^2 = .50$, including SSG2 vs. SG; $d_g = -2.46$, large), demonstrating that SSG2 demands the performance of faster actions compared with SSG4/SG. Consequently, there were lower moderate accelerations and decelerations per minute in SSG4/SG compared with SSG2 ($p < .01$; $.77 < \eta_p^2 < .81$). However, more sprints were performed in SG compared with SSG2 ($p < .05$; $\eta_p^2 = .32$).

Comparison Between Sport Classes

Descriptive scores and pair comparisons between para-footballers' sport classes for all the internal and external load measurements are included in Supplementary Tables (available online) according to every game task: SSG2 (Supplementary Table S1 [available online]), SSG4 (Supplementary Table S2 [available online]), and SG (Supplementary Table S3 [available online]).

The SSG2 is the game situation with more between-group significant differences. The between-group analysis revealed significant differences for five variables in the SSG2 situation: Vel_{max} ($p < .01$), distances covered at the highest intensities (i.e., Z5, $p = .010$; Z6, $p < .01$), moderate accelerations ($p = .01$), and number of sprints ($p < .01$). In terms of physical demands, FT3 players reached significantly faster speeds than FT1 and FT2 players ($p < .05$; $-3.35 < d_g < -4.64$, large), as did the FT2 compared with the FT1 players ($p < .05$; $d_g = -0.81$, large). Also, the FT3 players covered more distance during the SSG2 compared with the FT1 and FT2 players ($-0.95 < d_g < -1.09$, large). Concerning the distances covered at different intensities, again, the FT3 covered more distances at the highest intensities compared with FT1 and FT2 players ($p < .05$; $-1.36 < d_g < -4.00$, large). Large to moderate effect sizes were also found for Z3 and Z4, demonstrating that FT3 players covered more distances than FT1 ($-0.82 < d_g < -1.58$, large) and FT2 ($-0.57 < d_g < -0.79$, moderate) at these intensities. With regard to the distances covered at the lowest intensities, we found that FT1 and FT2 covered more distance at Z1 compared with FT3 players ($0.80 < d_g < 0.82$, large). Regarding the short-term action variables, FT3 players performed more moderate/high accelerations/decelerations than FT1 ($p < .05$; $-1.07 < d_g < -2.89$, large), and large effect sizes were also found for the moderate/high accelerations when comparing with FT2 players ($-0.85 < d_g < -0.90$). Moderate to large effect sizes were also found for moderate accelerations and moderate/high accelerations between FT2 and FT1 players ($-0.66 < d_g < -1.13$). Similar differences were found for the number of sprints performed during the task; the FT3 players performed more sprints than FT1 and FT2 players ($p < .05$; $-1.30 < d_g < -2.45$, large), and moderate effect size was also found between FT2 and FT1 ($d_g = -0.76$).

In the SSG4 situation, no significant differences were observed in the physiological and physical demands. However, like the SSG2, large effect sizes were found when comparing FT3 and FT1 players for Vel_{max}, distances covered at Z4 and Z6 intensities, and high/moderate accelerations ($-0.88 < d_g < -1.26$). For this comparison, there are large effect sizes for HR_{mean} ($d_g = -1.09$) and RPE ($d_g = -1.09$). When comparing FT1 and FT2 players, large effect sizes were found to demonstrate that FT2 players covered more distance at Z6 and performed more decelerations at high intensity ($d_g = -0.81$). When comparing the FT2 and FT3 players, large effect sizes demonstrated that FT3 had lower RPE and covered a large TD and a smaller distance at Z1 ($0.80 < d_g < 1.05$).

In the SG, between-group significant differences were only found for the distance covered at Z1 ($p = .01$), where FT1 and FT2 players had higher scores compared with FT3 players ($1.72 < d_g < 3.39$). The pair comparisons also revealed large effect sizes in line with the previous findings for the SSGs: TD (FT3 > FT1; $d_g = -1.32$), Vel_{max} (FT3 > FT1 and FT2; $-0.82 < d_g < -1.00$), and distance covered at Z2 (FT3 > FT1 and FT2; $-0.90 < d_g < -1.80$). Additional findings were found for the HR_{peak} (FT2 > FT1 and FT3; $-0.96 < d_g < 1.51$, large).

Between-Factors Interactions

The mixed 3 × 3 analysis of variance revealed significant between-factor interactions (i.e., game situation as within-group factor and sport classes as between-group factor) in several external load variables: distances covered at Z4, $F(2, 11) = 5.57$; $p = .02$; $\eta_p^2 = .50$, and Z5, $F(2, 11) = 3.35$; $p < .05$; $\eta_p^2 = .38$; sprints count, $F(2, 11) = 4.24$; $p = .04$; $\eta_p^2 = .44$; and moderate accelerations, $F(2, 11) = 7.17$; $p = .01$; $\eta_p^2 = .57$.

Discussion

The SSGs contribute in an important form to the improvements of physical–technical demands and comprise multiple objectives during the performance of football (i.e., soccer) games (Sarmento et al., 2018). However, there is little evidence of SSG and SG differences and how they could affect the performance of CPFPs belonging to different sport classes. Thus, this study aimed to compare the physical performance of CPFPs during two formats of SSG (2-a-side and 4-a-side) and SG and to determine the differences between the new sports classes (i.e., FT1, FT2, and FT3) recently introduced in CP football.

Comparison of Game Situations

Several studies described SSG internal and external load values in regular football (Castellano et al., 2013; Dellal et al., 2012; Köklü et al., 2011, 2012). Also, SSG time–motion characteristics have an important relationship with the effect of the number of players, pitch size, and time duration of the game (Hill-Haas et al., 2011). However, little is known about the physiological responses and physical demands of different training tasks in CP football. With regard to the internal load, moderate to large effect sizes were found between SSG4 and SSG2/SG situations for the HR_{peak}, and this tendency is in line with a previous study wherein higher values were found in SSG4 (179 ± 8.4 beats/min) compared with SSG2 (172.3 ± 10.0 beats/min; Köklü et al., 2011). However, the scores found by Köklü et al. (2011) with elite young soccer players are lower than the scores of the CPFPs of this study (SSG2 = 191.3 ± 5.4 beats/min, SSG4 = 197.3 ± 9.4 beats/min), demonstrating that those with CP reach higher HR_{peak} than their nondisabled counterparts (Maltais et al., 2004; Runciman et al., 2016). With regard to RPE, significant differences were found between the two SSG situations, with higher scores in the 2-a-side game, but also a large effect size was found compared with the SG. This finding is in line with Aguiar et al. (2013), reinforcing that in CPFPs, too, RPE increases with a lower number of players in comparison with the presence of more participants during the football game.

Concerning the external load, between-game situation differences were found for all the measured variables, excepting the distances covered at Z1 and Z4 intensities. Regarding the physical demands, our study found that TD (in meters per minute) obtained higher values in SSG2 compared with a larger number of players in the different formats during the performance of the game, and this finding is contrary to previous studies, which reported more distance covered during a game with more players involved in the SSG (Dellal et al., 2011; Hill-Haas et al., 2009). In consequence, the lowest Vel_{max} was found in SSG2 compared with SSG4 and SG, but these results are similar with other studies with nondisabled football players (Casamichana & Castellano, 2010; Castellano et al., 2013). This overall response might be related to the distances covered at different intensities, with higher scores at Z2 in the two SSG situations compared with SG, but the performance of faster actions in the SG taking into account the significant differences obtained for Z5 and Z6. These differences can be explained because a large pitch permitted a greater range of covered distance during high-intensity activities (Aguiar et al., 2013; Hill-Haas et al., 2009, 2011).

The aforementioned findings would be related to the short-term actions, that is, there were lower moderate accelerations and decelerations per minute in the SG compared with SSG2 and SSG4 as well as between SSG4 and SSG2 tasks. According to different authors, there is an increase in acceleration/deceleration demands in the SSGs as there are fewer players on the pitch (Gaudino et al., 2014; Rebelo et al., 2016), and this is in line with our study since the CPFPs performed more moderate accelerations and decelerations in the SSG2 compared with the other game formats. This finding is relevant for classification purposes not only because this format is more feasible for an athlete's technical assessment in terms of player availability during classification and risk management (i.e., involving players from the same team) but also because it could represent higher mechanical and neuromuscular demands for the CPFPs. This higher frequency in the number of changes of velocity is related to the smaller SSG format, and this characteristic should be considered during the performance of CPFPs and the expected demands of the game (Gaudino et al., 2014). Therefore, acceleration/deceleration is an important parameter recommended for the characterization of the physical demands of SSGs and has a greater impact on the energetic and neuromuscular systems (Rebelo et al., 2016). Previous research reported an increase in physical demands when the pitch size and number of players decreased, suggesting demanding requirements of eccentric muscular work and the use of anaerobic metabolism (Rebelo et al., 2016).

Overall, the first hypothesis of this study is partly demonstrated since the SSG tasks require higher physiological demands (i.e., internal load) and provoke the completion of a longer TD and the performance of high/moderate accelerations/decelerations. However, the SG task allowed the performance of higher speeds and distances covered at the highest intensities (i.e., Z5 and Z6).

Comparisons Between Sport Classes

The sport classes introduced in CP football since 2018 obey the International Paralympic Committee's position regarding evidence-based and sport-specific classification in para-sports (Tweedy & Vanlandewijck, 2011), establishing relationships between the eligible physical impairments of hypertonia, athetosis/dystonia, and ataxia and the activity limitation when performing the required football skills for the game. In CP football, sports classes FT1, FT2, and FT3 are ranked from a high to low impairment, that is, from more to less activity limitation for performing football skills (IFCPF, 2018a). With regard to the internal load, no significant differences were found for either the objective (i.e., HR) or the subjective (i.e., RPE) measurements in the three game situations.

In terms of the physical demands (i.e., TD and Vel_{max}), FT3 players covered more distance (in meters per meter) and reached higher speeds (in kilometers per hour) in the two formats of SSG and the SG. These findings are in concordance with those belonging to the FT8-sports-class players (i.e., minimum impairment) classified in the previous classification system. The FT8 players covered the highest TD during the real game (Yanci et al., 2018) and performed faster displacements (Reina et al., 2020) compared to other sport classes. These differences between sport classes can be explained because FT1 and FT2 players present a higher impairment in comparison with FT3 players, and this would be related to a higher compromise in muscle coactivation, lower levels of motor unit recruitments, and muscle weakness (Hussain et al., 2014). Also, these differences between sports classes may be related to a decrement in the strength of the knee extensor and flexor musculature, constraining the performance of high-intensity activities (Maly et al., 2018), especially in the SSG2, where between-group differences were found. The pitch ratio per player is another factor to be considered to explain these findings, that is, those players with less impairment would cover a greater TD (Köklü et al., 2012) and at faster speeds. In consequence, players with less impairment would assume more relevant roles in tactical functions during the play (Yanci et al., 2018), compensating for the displacement limitations of other teammates with more activity limitation.

Concerning the distance covered at different intensities, in the SSG2, FT3 players exhibited significantly higher scores than FT1 and FT2 in the Z5 and Z6. Also, large effect sizes were found between FT3 versus FT1 in Z3/Z4 and in Zones 4 and 6 in the SSG4 when comparing these sport classes. According to the CP football classification rulebook (IFCPF, 2018a), FT3 players present little or minimal compromise in balance, running, change of direction, jumping, and performing football skills compared with FT1 and FT2, so these characteristics could suggest the differences in high-speed zones between classes. However, these results demonstrate that SSG2 cannot simulate these high-intensity demands of a real game (over Z5; >16 km/hr) compared with other studies where players with a minimum impairment can reach 4.53 ± 3.01 m/min (Yanci et al., 2018) to 4.97 ± 2.97 m/min (Reina et al., 2020) and sprinting over >18 km/hr. In contrast, the performance shown in SSGs is in concordance with other studies with players without disability wherein the high-intensity activities were lower compared with competition demands (Aguiar et al., 2013; Gabbett & Mulvey, 2008). In addition, FT1/FT2 players covered higher distances in Z1 compared with FT3 players in the three game situations, and this is similar to findings from official games wherein players with the minimum impairment covered lower distances at low intensity compared with players with more activity limitations (Yanci et al., 2018).

Regarding the short-term actions (i.e., accelerations and decelerations) and the sprint counts, the main significant differences were found in the SSG2 situation together with large effect sizes between FT1 versus FT3 in the SSG4 for the moderate/high accelerations. Again, those with a lower level of impairment exhibited better performance in this type of short- and high-intensity actions (Reina et al., 2020). Those players with a higher impairment severity experienced lower muscle power production, muscular imbalances, muscular coactivation, and body asymmetries, which explain their difficulties in performing high-intensity activities (Hussain et al., 2014; Reina et al., 2018), provoking an underperformance and the presence of fatigue during the SSGs (Runciman et al., 2016; Yanci et al., 2019). Therefore, the smallest pitch size in the SSGs permitted the FT3 players to perform more moderate accelerations and number of sprints, exhibiting a higher proficiency during the game (Akenhead et al., 2013). Here, acceleration is described as a previous factor of high-speed running with significant demands of strength generation and neural activation in lower limbs (Akenhead et al., 2013; Di Prampero et al., 2005), explaining why those with more impairment exhibit reduced power and/or speed performance (Reina et al., 2018; Yanci et al., 2018). The similar differences found between FT2 and FT1 players (moderate to large effect sizes) support the suggestion that high-intensity actions are a relevant factor to describe CP football performance (Reina et al., 2020) and to discriminate between players with different levels of impairment (Pastor et al., 2019). Nevertheless, to the best of the authors' knowledge, this is the first study replicating these findings with SSGs. Moreover, the differences in the performance between sports classes can be related to the specific characteristics presented in CPFPs wherein muscular, neural, and metabolic factors constrain the development of motor patterns in SSGs (Hussain et al., 2014; Runciman et al., 2016). Hence, our second hypothesis would be confirmed, especially for the between-group comparisons in the SSG2 task wherein FT3 players reached higher speeds, completed a longer TD, covered longer distances at the highest speed zones, and performed more high/moderate accelerations/decelerations and more sprints.

Practical Implications and Study Limitations

This study has some practical implications from the classification and coaching perspectives. From a classification perspective, the 2-a-side SSG format would be the best task for the technical assessment of CPFPs because it demands short and high-intensity actions that better discriminate between different levels of impairment or sports proficiency, especially when comparing para-footballers belonging to the FT3 versus FT1/FT2 sport classes. Although moderate to large effect sizes were found between FT1 and FT2 for several high-intensity variables, further research is necessary to reinforce these results. Although the presented results could indicate that smaller pitch formats of SSG could be useful to increase the physical and physiological demands necessary to observe activity limitation of different CP football sport classes, it could be difficult to replicate the real competition demands according to the differences presented in the execution of the tasks.

From a coaching or training perspective, the findings from this study would help to monitor physical/physiological working aspects during training. In other words, coaches and physical trainers can better understand how game situations played on smaller pitches or with a smaller number of players affect the players' internal and external loads. Also, the demonstrated varying performance by players belonging to different sport classes would help coaches to consider the best plan in concordance with disability characteristics and session goals.

There are some limitations in this study. First, the limited number of players per sport class would limit the generalization of the findings according to the performance in the different game formats. Second, the lack of a counterbalance of the game formats and a random assignment are noteworthy methodological limitations of this study. Further studies are needed to explore different SSG protocols, focusing on the comparison of the new CP football sport classes performing high-intensity actions during the game.

Conclusions

The physical demands of eligible players during a game of CP football showed lower performance compared with nondisabled football players in the capacity of changing directions and performing fast actions at a high intensity (Yanci et al., 2019). The classification profile also has an impact on the kinematic patterns and time–motion characteristics during game play, where players with minimum impairment criteria are distinguished from the other classes (Reina et al., 2020; Yanci et al., 2018). It seems that pitch size and classification profile (i.e., sports class) influence many of the external load variables measured in this study, especially in the SSG2 and when comparing FT3 versus FT1/FT2 players.

Our results also suggest that SSG2 can be useful for the improvement of acceleration/deceleration actions, which are also related to high-speed running and make important demands on concentric and eccentric working muscles (Akenhead et al., 2013). This type of game format could be an advantage for the improvements of synergistic muscle groups responsible for acceleration/deceleration actions because many of the CPFPs are affected by muscle coactivation, a negative component of movement and an issue of increased musculoskeletal injuries (Hussain et al., 2014; Runciman et al., 2016). In agreement with this and based on the presented results, SSG4 would be appropriate to achieve greater maximum speed, a higher number of sprints, and to cover more distances at a high intensity than SSG2. Special emphasis must be considered in the organization of an SSG based on the typical factors that influence the physical demands, methodological goals, and classification characteristics of CPFPs.

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