

Article

Association between Activity Limitation and Match Physical Responses of International-Level Female Footballers with Cerebral Palsy.

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Abstract: Objectives: Cerebral palsy (CP) football for female players has a recent development in an international scenario, so this study aimed: (a) to describe performance in activity limitation tests and physical responses in official competition among international-level women's footballers with CP and according to their sport classes, and (b) to analyze the association between key activity limitation tests used during classification and relevant physical response variables in competition. Methods: Thirty-five para-footballers from five national teams that competed in a World competition participated in the study. A cross-sectional and correlational design was used to examine the associations between activity limitation tests and physical responses during competition. Activity limitation was assessed by measuring players' jump capacity, coordination skills, change of direction ability and acceleration capacity. Physical responses were recorded during matches using global positioning system devices. Results: Descriptive data of performance test showed better values in the sport classes with lower impairment. In addition, FT1 players registered the lowest values of physical responses. Significant associations between horizontal jump capacity ($Rho = 0.64$ to 0.76 , $p < 0.05$), change of direction ability ($r/Rho = -0.68$ to -0.85 , $p < 0.05$), and acceleration ($r = -0.84$ to -0.86 , $p < 0.001$) capacity with high-intensity competition variables were found in FT1 players. In addition, a



significant association between change of direction ability ($Rho = -0.51, p < 0.05$) and acceleration capacity ($Rho = -0.50, p < 0.05$) with the match-specific high-intensity acceleration/deceleration variables was observed in FT2 players. Conclusion: Competition performance in female CP football players that have less activity limitation could be associated with other types of capacities or factors. These results could contribute to optimizing classification protocols and class allocation in female PC football players.

Keywords: soccer, women, brain impairment, match load, classification, para-sport

1. Introduction

Cerebral Palsy (CP) football for women is a para-sport practiced by players with CP or acquired brain injuries involving eligible motor-related neurological impairments (Henríquez et al., 2024). In this modality of CP football, each team consists of five players, with two halves of 25 minutes each, and is played in a field of specific dimensions (i.e., 40 x 27 m), and goals posts (i.e., 5 x 2 m), where the offside rule is not applied (IFCPF, 2023). Although men's CP football has a long competitive history that began with its first international championships in 1982 (Peña-González et al., 2024) the women's CP football modality has been developing in recent years, with participation growing exponentially across all fields and competitive levels (Henríquez et al., 2023). To be eligible for competition, female players with CP must present a permanent neurological impairment of spastic hypertonia, motor ataxia, or dyskinesia, significantly impacting football performance (Henríquez et al., 2024; IFCPF, 2024). As in the men's modality, the classification process provides a framework

to balance the impact of the physical impairment on performance outcomes, by categorizing para-athletes and grouping them in sports classes (FT) before meeting a sport-specific minimum impairment criteria and undergoing physical, technical, and observational assessments in competition (Tweedy & Vanlandewijck, 2011). Once the athlete is eligible to play CP football, players can then be classified in sport classes of FT1, FT2, or FT3 (e.g., from most to least severe impairment) based on their functional profile, which includes bilateral spasticity or diplegia, overall coordination disorders, and unilateral spasticity or hemiplegia (Peña-González et al., 2021).

Although significant progress has been made in men's CP football regarding sports performance analysis and evidence-based classification research (Peña-González et al., 2021; Reina et al., 2020; Yanci et al., 2018), scientific studies on women's CP football remain limited (Henríquez et al., 2023; Henríquez et al., 2024). To establish scientific evidence concerning classification processes, Tweedy et al. (2014) proposed that evidence-based classification must include

the measurement of activity limitation and the assessment of the association between disability measures and performance tests, among other aspects. Initial studies have already addressed the assessment of activity limitation of women's CP football modality (Henríquez et al., 2023; Henríquez et al., 2024). However, to the best authors' knowledge, there are no studies in women's CP football taking into account the possible association between the impact of the impairment on activity limitation and its association with the real physical response in competition.

Previous studies in men's CP football have analyzed the relationship between performance in activity limitation tests and physical responses in competition by previous classification system's sport classes (Reina et al., 2020; Reina et al., 2021). For instance, Reina et al. (2020) examined the association between activity limitations including different physical tests and the physical responses of players with CP in competitive matches suggesting different impairment-specific relationships. This knowledge has led to a better understanding of the sports proficiency required for each sport class in this team para-sport, favoring the class allocation and the classification system as a framework for the competition (IFCPF, 2024). However, no studies have analyzed the association between activity limitation and physical responses in

competition within the women's CP football modality. Considering that the men's and women's modalities differ significantly (Peña-González et al., 2024), and consequently in the physical demands, there is a need to provide scientific evidence, thereby supporting classifiers and enhancing the understanding of the required athletic competence in each sport class for women's CP football players. Therefore, the objectives of this study were: (a) to describe performance in various activity limitation tests and physical responses in official competition among international-level women's CP football players according to their sport classes, and (b) to analyze the association between activity limitation tests and physical response variables in competition for all players and by sport class.

2. Materials and Methods

Subjects — Thirty-five international-level female CP football players (24.9 ± 8.3 years; 163.5 ± 7.0 cm; 59.0 ± 13.7 kg; 22.2 ± 3.5 kg·m⁻²) from five national teams that competed in the International Federation of CP Football (IFCPF) 2022 World Cup (Salou, Spain), representing the 77.78% of the total number of footballers who participated in that competition (Table 1). All players trained 2-3 days per week and averaged 4.8 ± 4.3 years of experience in CP football. Inclusion criteria for participation included holding a valid IFCPF license, being selected by their country/national team to compete in this

event and competing internationally in an official tournament. Exclusion criteria included any injury during data collection or regular play as a goalkeeper due to the specific role during the match. Players were grouped by sport class (IFCPF, 2024) as follows: Class 1 players (FT1, highest impairment level, $n = 12$, 27.9 ± 10.6 years) Class 2 players (FT2, moderate impairment level, $n = 19$, 22.6 ± 6.0 years), and Class 3 players (FT3, low impairment level, $n = 4$, 25.5 ± 4.8 years). Before the study, participants and national teams were informed of the study procedures, could withdraw at any time, were aware of the research risks, and signed an informed consent form. All procedures in this study were approved by the Ethics Committee of ***for blind purposes*** (reference number ***for blind purposes***).

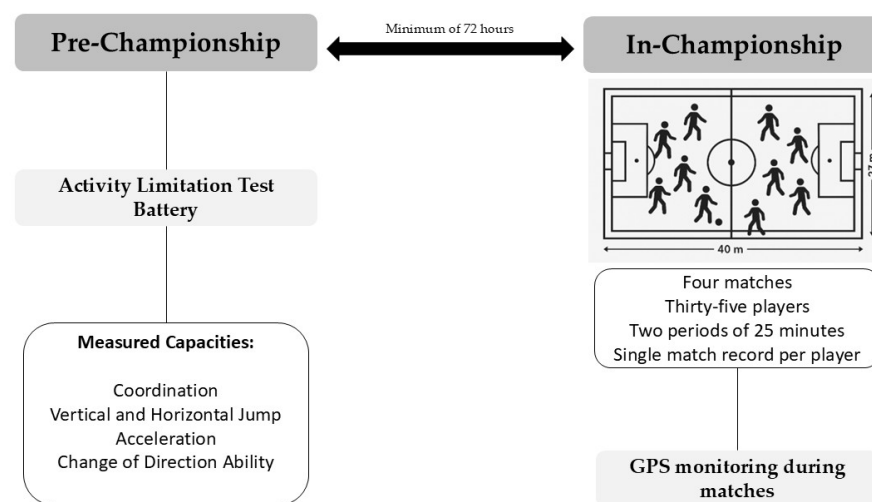
Design — A correlational design was used to examine the relationships between performance levels in activity limitation tests and physical responses during competition (Figure 1). A minimum of 72 hours before official matches, players' activity limitations were assessed through tests of coordination (i.e., split jumps and side-stepping), vertical and horizontal jump power (i.e., countermovement jump: CMJ and standing broad jump: SBJ), acceleration (i.e., 10-m sprint), and change of direction ability (CODA) (i.e., dribbling speed test: DST and 505) (Reina et al., 2020). Players performed a

standard warm-up consisting of 10 min of jogging and progressive motor actions similar to those tests (Henríquez et al., 2024). Each player completed the coordination, jump power, acceleration, and CODA tests. Tests were conducted in the same order for all participants and in the same indoor facilities. Additionally, all official matches analyzed were played at the same sports venue, an artificial grass football field measuring 40×27 m. Each match lasted 50 min of regulation time, divided into two halves (0-25 min and 25-50 min) (IFCPF, 2023). Players' physical responses were monitored during each official match played in the championship group stage. A single match record was obtained for each player, with data from four out of the twelve matches in the championship recorded. All physical response variables, except for the maximum speed reached, were normalized based on the minutes played by each player. Players participated in 33.46 ± 15.56 min (minimum = 4:00 min, maximum = 56:58 min).

Table 1. Characteristics of the Female Football Players with Cerebral Palsy

	Total	FT1	FT2	FT3
Number of observations	35	12	19	4
Age (y)	24.9 ± 8.3	27.9 ± 10.6	22.6 ± 6.0	25.5 ± 4.8
Height (cm)	163.5 ± 7.0	161.6 ± 7.4	164.8 ± 6.5	165.0 ± 7.9
Body mass (kg)	59.0 ± 13.7	54.0 ± 10.1	61.5 ± 14.8	67.6 ± 17.1
BMI (kg·m ⁻²)	22.2 ± 3.5	20.5 ± 2.3	22.5 ± 4.3	24.5 ± 4.0

Note. BMI = body mass index; FT = sport class. Data are presented as mean ± standard deviation.

**Figure 1.** Experimental design of the study. GPS = global positioning system.

Methodology — **Activity Limitation Tests:** The test battery used to measure activity limitation in CP footballers was adapted from tests previously used by Reina et al. (2020) and Peña-Gonzalez et al. (2021) in men's CP football and is part of the assessment tests in the classification process for both men's and women's CP football (IFCPF, 2024). Vertical jump capacity was measured using the CMJ test (Reina et al., 2020; Yanci et al., 2016), and horizontal jump capacity was assessed using the SBJ test (Reina et al., 2020). Coordination was measured using the side-stepping (Beckman & Tweedy, 2009; Reina et al., 2020) and split

jumps tests (Beckman & Tweedy, 2009; Reina et al., 2020). CODA was measured using the 505 test (Reina et al., 2020) and DST (Peña-González et al., 2021). Sprint capacity was measured by a stationary 10-m sprint (Henríquez et al., 2023).

Physical Responses in Competition: Physical responses were recorded during matches using WIMU PRO devices (RealTrack Systems, Almería, Spain), operating at a 10 Hz sampling frequency and previously used to measure the physical responses of male CP players (Gamonaes et al., 2022). The validity and reliability of WIMU PRO for time-motion analysis in

football had been verified previously (Bastida-Castillo et al., 2018). Records were downloaded using SPRO software (RealTrack Systems, version 983 Almería, Spain) after each match concluded. Total distance covered ($\text{m}\cdot\text{min}^{-1}$) (Gamonaes et al., 2022; Yanci et al., 2018), distance ($\text{m}\cdot\text{min}^{-1}$) covered at different intensity intervals (walking: $< 6.0 \text{ km}\cdot\text{h}^{-1}$, jogging: $6.01\text{--}12.0 \text{ km}\cdot\text{h}^{-1}$, medium-speed running (MSR): $12.01\text{--}18.0 \text{ km}\cdot\text{h}^{-1}$, high-speed running (HSR): $> 18.01 \text{ km}\cdot\text{h}^{-1}$) (Gamonaes et al., 2022), explosive distance ($\text{m}\cdot\text{min}^{-1}$) (distance covered at an acceleration greater than $1.12 \text{ m}\cdot\text{s}^{-2}$) (Peña-González et al., 2021), distance ($\text{m}\cdot\text{min}^{-1}$) covered during accelerations and decelerations of different intensities (moderate-intensity accelerations (Mod-Acc): $< 3.00 \text{ m}\cdot\text{s}^{-2}$, moderate-intensity decelerations (Mod-Dec): $< -3.00 \text{ m}\cdot\text{s}^{-2}$, high-intensity accelerations (High-Acc): $> 3.01 \text{ m}\cdot\text{s}^{-2}$ and high-intensity decelerations (High-Dec): $> 3.01 \text{ m}\cdot\text{s}^{-2}$) (Gamonaes et al., 2022) and maximum velocity (Vel_{max}) reached ($\text{km}\cdot\text{h}^{-1}$) (Yanci et al., 2018) were calculated from WIMU PRO device data.

Statistical Analysis — Results are presented as mean and standard deviations for all players and by sport class. The Shapiro-Wilk test was applied to assess data normality, and the Levene test was used to verify homoscedasticity. Pearson's correlation coefficient (r) with 95% confidence intervals (CIs) was used to

examine the relationship between activity limitation test outcomes and physical response variables for normally distributed data. However, Spearman's correlation coefficient (Rho) with 95% CIs was used to examine the relationship between activity limitation test outcomes and physical response variables for data that were not normally distributed. The following magnitude scale was used to interpret correlation coefficients: <0.10 , trivial; $0.1\text{--}0.29$, small; $0.30\text{--}0.49$, moderate; $0.50\text{--}0.69$, high; $0.70\text{--}0.89$, very high; and >0.90 , nearly perfect (Hopkins et al., 2009). Data were analyzed using JASP software (JASP for Windows, version 0.16, Amsterdam, Netherlands). Statistical significance was set at $p < 0.05$.

3. Results

Regarding the jumping ability, the total group of players achieved a CMJ performance of $18.51 \pm 5.77 \text{ cm}$, while FT1, FT2, and FT3 class players jumped $14.57 \pm 4.98 \text{ cm}$, $20.50 \pm 5.61 \text{ cm}$, and $20.98 \pm 1.76 \text{ cm}$, respectively. In the SBJ test, the overall group obtained results of $125.06 \pm 34.60 \text{ cm}$, while results by sport classes (i.e., FT1, FT2, and FT3) were $104.36 \pm 34.60 \text{ cm}$, $130.89 \pm 29.96 \text{ cm}$, and $155.75 \pm 25.77 \text{ cm}$, respectively. The results obtained by the total group of players and by players in each sport class in the split jumps, side-stepping, 505, DST, and sprint tests are shown in Figure 2

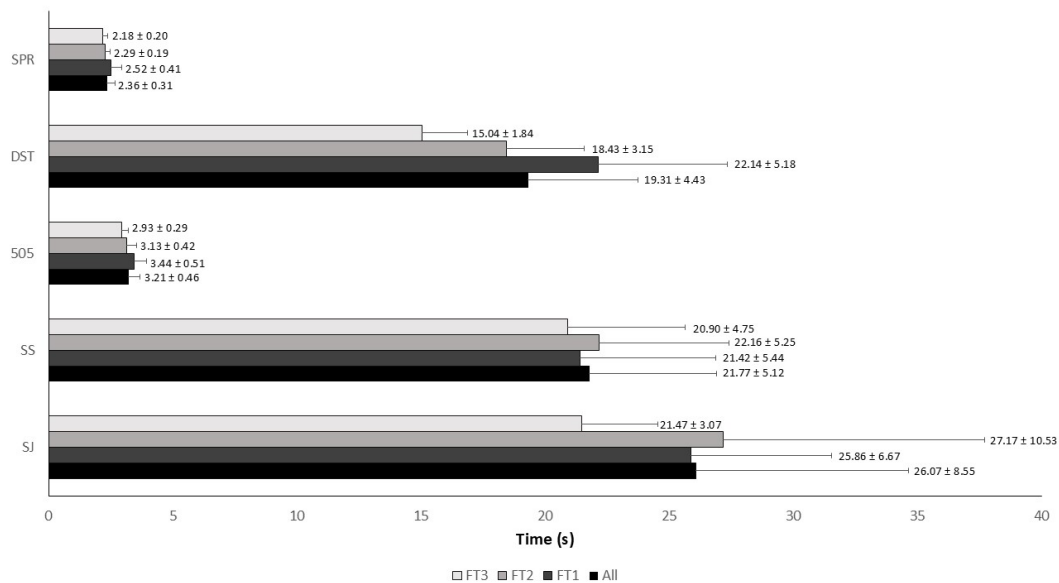


Figure 2. Execution time (s) in each activity limitation test for all players and sport classes (FT1, FT2, and FT3). SJ = split jump test; SS = side stepping test; 505 = 505 test; DST = dribbling speed test; SPR = 10-m sprint test; FT1 = sport class 1; FT2 = sport class 2; FT3 = sport class 3.

About the physical response variables during matches, all players covered a total distance of $66.80 \pm 9.57 \text{ m} \cdot \text{min}^{-1}$, while FT1, FT2, and FT3 players covered $62.54 \pm 9.43 \text{ m} \cdot \text{min}^{-1}$, $68.29 \pm 9.22 \text{ m} \cdot \text{min}^{-1}$, and $72.52 \pm 8.42 \text{ m} \cdot \text{min}^{-1}$, respectively. For the explosive distance, CP players covered a distance of $5.53 \pm 2.00 \text{ m} \cdot \text{min}^{-1}$, while FT1, FT2, and FT3 class players covered $4.44 \pm 1.44 \text{ m} \cdot \text{min}^{-1}$, $6.16 \pm 2.10 \text{ m} \cdot \text{min}^{-1}$, and $5.79 \pm 1.89 \text{ m} \cdot \text{min}^{-1}$. Additionally, players reached a Vel_{max} of $17.69 \pm 2.26 \text{ km} \cdot \text{h}^{-1}$, while each sport class reached a Vel_{max} of $16.06 \pm 1.94 \text{ km} \cdot \text{h}^{-1}$ (FT1), $18.55 \pm 2.84 \text{ km} \cdot \text{h}^{-1}$ (FT2), and $18.48 \pm 1.97 \text{ km} \cdot \text{h}^{-1}$ (FT3). Figure 3A presents the descriptive values of distances covered at different intensities, and Figure 3B shows the distances covered at moderate and high accelerations and decelerations for all players and by each profile.

Concerning the associations between activity limitation tests and the physical responses during matches, for the total players, the CMJ test showed a significant association with explosive distance and Vel_{max} ($r = 0.38$ to 0.69 , 0.26 to 0.83 , 95% CI, $p < 0.05$, moderate-high) and with MSR, HSR (Rho = 0.66 , 0.41 to 0.81 , 95% CI, $p < 0.001$, high) (Figure 4A), Mod-Dec, High-Acc (Rho = 0.56 , 0.28 to 0.76 , 95% CI, $p < 0.001$, high) (Figure 3B), and High-Dec (Rho = 0.52 , 0.23 to 0.73 , 95% CI, $p < 0.001$, high). Similarly, the SBJ test were associated with the explosive distance and Vel_{max} variables ($r = 0.52$ to 0.59 , 0.22 to 0.77 , 95% CI, $p < 0.01$, high) MSR and HSR (Rho = 0.42 , 0.08 to 0.66 , 95% CI, $p < 0.05$, moderate) (Figure 4A), High-Acc (Rho = 0.53 , 0.23 to 0.74 , 95% CI, $p < 0.01$, high) (Figure 4B), and High-Dec (Rho = 0.52 , 0.23 to 0.74 , 95% CI, $p < 0.01$, high). Significant negative

correlations were also observed between the split jumps test and the physical response variables of total distance, jogging distance, MSR, HSR (Rho = -0.34, -0.60 to -0.06, 95% CI, $p < 0.05$, moderate) (Figure 4A), Vel_{max} , Mod-Acc, Mod-Dec, and High-Acc (Rho = -0.39, -0.64 to -0.07, 95% CI, $p < 0.01$, moderate) (Figure 4B). Similarly, the 505 test negatively correlated with total and explosive distances, MSR, HSR (Rho = -0.39, -0.64 to -0.06, 95% CI, $p < 0.05$, moderate) (Figure 4A), Vel_{max} , Mod-Acc, Mod-Dec, High-Acc (Rho = -0.50, -0.72 to -0.20, 95% CI, $p < 0.01$, high) (Figure 4B), and High-Dec (Rho = -0.58, -0.77 to -0.31, 95% CI, $p < 0.05$, high). Additionally, significant negative correlations were also observed between the DST and explosive distance, MSR, HSR (Rho = -0.48, -0.70 to -0.27, 95% CI, $p < 0.01$, moderate) (Figure 4A), Vel_{max} , Mod-Dec, High-Acc (Rho = -0.43, -0.69 to -0.11, 95% CI, $p < 0.01$, moderate), and High-Dec (Rho = -0.59, -0.61 to -0.02, 95% CI, $p < 0.05$, high), as well as with the sprint test and the variables of total, explosive and jogging distances, HSR (Rho = -0.50, -0.71 to -0.19, 95% CI, $p < 0.01$, high) (Figure 4A), Vel_{max} , Mod-Acc, Mod-Dec, High-Acc (Rho = -0.48, -0.70 to -0.18, 95% CI, $p < 0.01$, moderate) (Figure 4B), and High-Dec (Rho = -0.61, -0.79 to -0.35, 95% CI, $p < 0.05$, high).

For FT1 players, significant positive correlations were found between the CMJ and MSR (Rho = 0.69, 0.20 to 0.91 95% CI, $p < 0.05$, high) and between the SBJ and the explosive distance and HSR variables (Rho = 0.64 to 0.76, 0.15 to 0.91 95% CI, $p < 0.05$, high-very high) (Figure 5A) and Vel_{max} ($r = 0.73$, 0.24 to 0.93 95% CI, $p < 0.05$, very high). On the other hand, the split jumps test was negatively correlated with the MSR (Rho = -0.76, -0.93 to -0.34 95% CI, $p < 0.01$, very high). At the same time, no significant correlation was found between the side-stepping and any analyzed variable. However, the 505 test negatively correlated with explosive distance and Vel_{max} ($r = -0.79$ to -0.85, -0.96 to -0.39 95% CI, $p < 0.01$, very high) and with HSR (Figure 4A) and High-Dec (Figure 5B) (Rho = -0.68 to -0.76, -0.93 to -0.17 95% CI, $p < 0.05$, high-very high), while the DST correlated with HSR (Figure 5A) (Rho = -0.71, -0.91 to -0.22 95% CI, $p < 0.05$, very high). On the other hand, negative associations were also found between the sprint and the variables of explosive distance and Vel_{max} ($r = -0.84$ to -0.86, -0.95 to -0.51 95% CI, $p < 0.001$, very high) and the variables of HSR (Figure 5A) and High-Dec (Figure 5B) (Rho = -0.75 to -0.76, -0.93 to -0.34 95% CI, $p < 0.01$, very high).

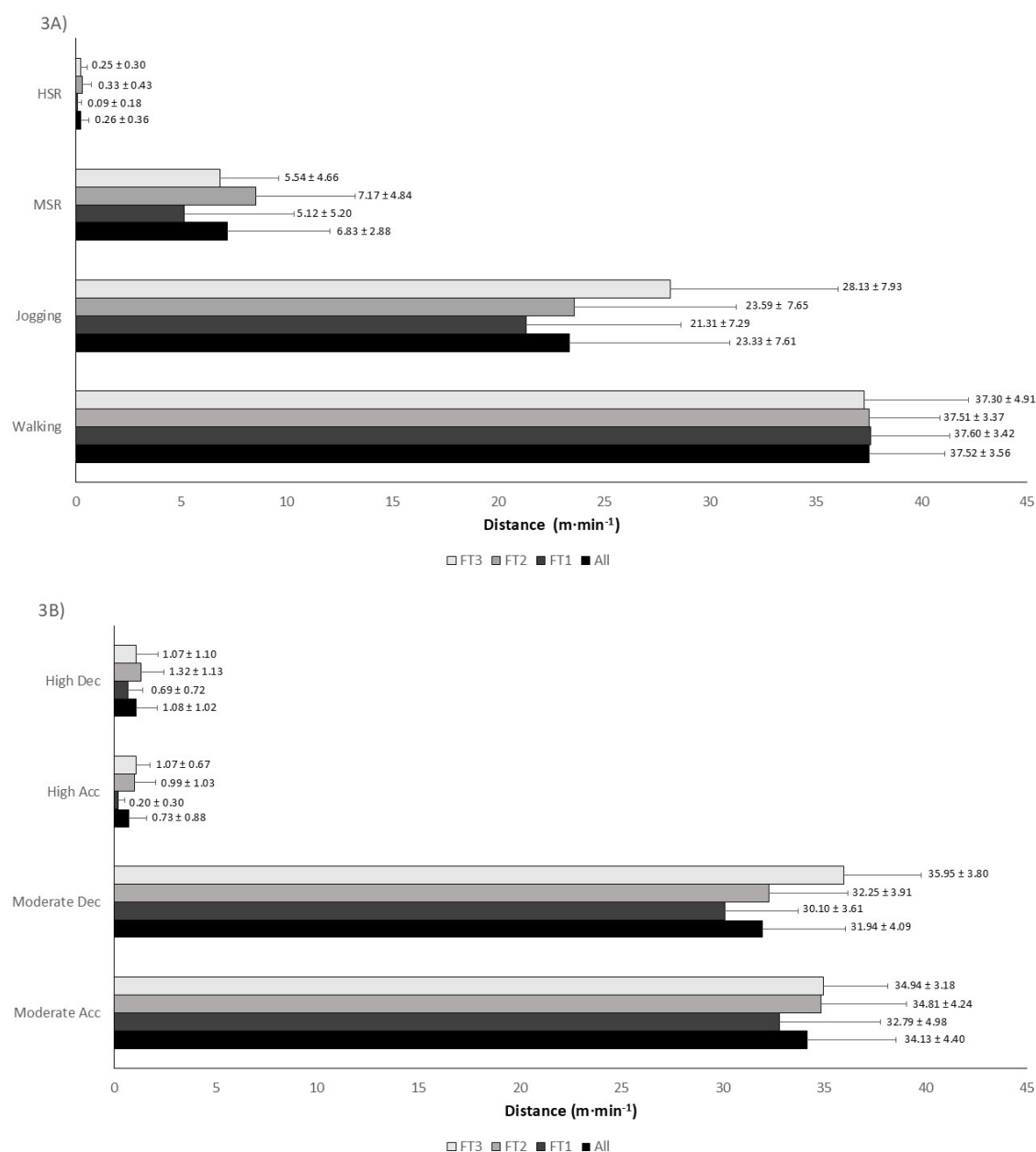


Figure 3. Distances covered at different speeds (m·min⁻¹) (3A) and at moderate and high-intensity accelerations and decelerations (3B) for all players and each functional class (FT1, FT2, and FT3). MSR = medium-speed running; HSR = high-speed running; Moderate Acc = moderate-intensity accelerations; Moderate Dec = moderate-intensity decelerations; High Acc = high-intensity accelerations; High Dec = high-intensity decelerations; FT1 = sport class 1; FT2 = sport class 2; FT3 = sport class 3.

Regarding players FT2, significant associations were found between the CMJ and the explosive distance ($r = 0.48$, 0.05 to 0.77 95% CI, $p < 0.05$, moderate) and between the CMJ and HSR, Vel_{max} , and High-Dec (Figure 6) ($Rho = 0.49$ to 0.62, 0.21 to 0.84 94% CI, $p < 0.05$, moderate-high). The SBJ also

positively correlated with explosive distance and High-Dec (Figure 6) ($r = 0.52$ to 0.84, 0.07 to 0.81 95% CI, $p < 0.05$, high-very high). Additionally, the split jumps test was significantly and negatively associated with total and explosive distances, Vel_{max} , Mod-Acc, High-Acc, and High-Dec (Figure 6) (Rho

= -0.46 to -0.62, -0.76 to -0.01 95% CI, $p < 0.05$, moderate-high), while the side-stepping was not associated with any of the variables analyzed. On the other hand, the 505 test negatively correlated with High-Dec (Figure 6) ($Rho = -0.51$, -0.79 to -0.08 95% CI, $p < 0.05$, high), while no associations were found between the DST and any of the analyzed

physical response variables. The sprint performance correlated negatively with High-Acc ($Rho = -0.50$, -0.78 to -0.06 95% CI, $p < 0.05$, high).

Finally, for those players with minimal impairments (i.e., FT3), only the CMJ correlated with TD ($r = -0.97$, -0.99 to -0.05 95% CI, $p < 0.05$, almost perfect).

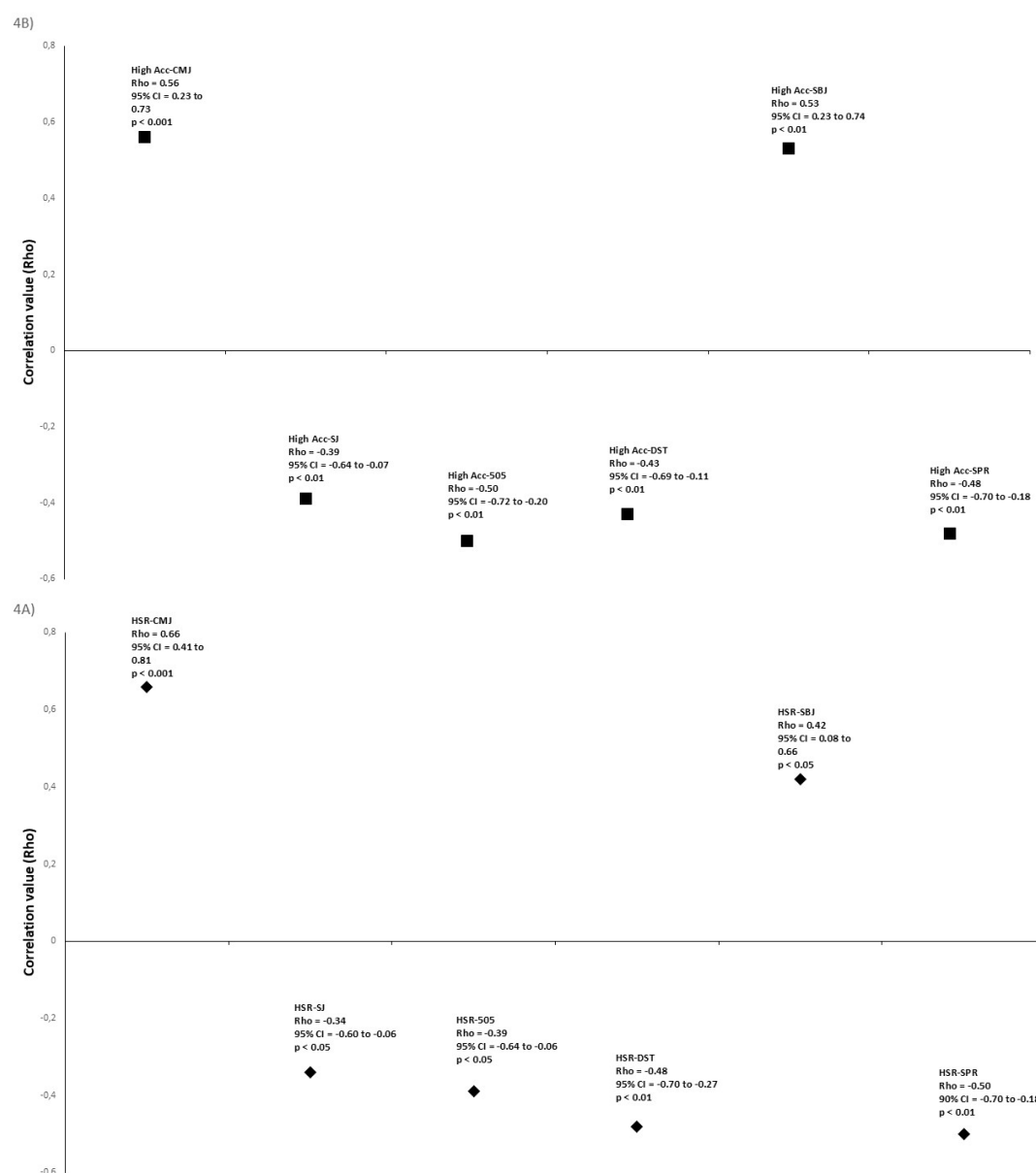


Figure 4. Correlation magnitudes between the variables HSR (4A) and High Acc (4B) with the CMJ, SJ, 505, DST, SBJ, and SPR tests for all players. HSR = high-speed running; High Acc = high-intensity accelerations; CMJ = countermovement jump; SJ = split jump; 505 = 505 test; DST = dribbling speed test; SBJ = standing broad jump; SPR = sprint test; Rho = Spearman's correlation; CI = Confidence Intervals.

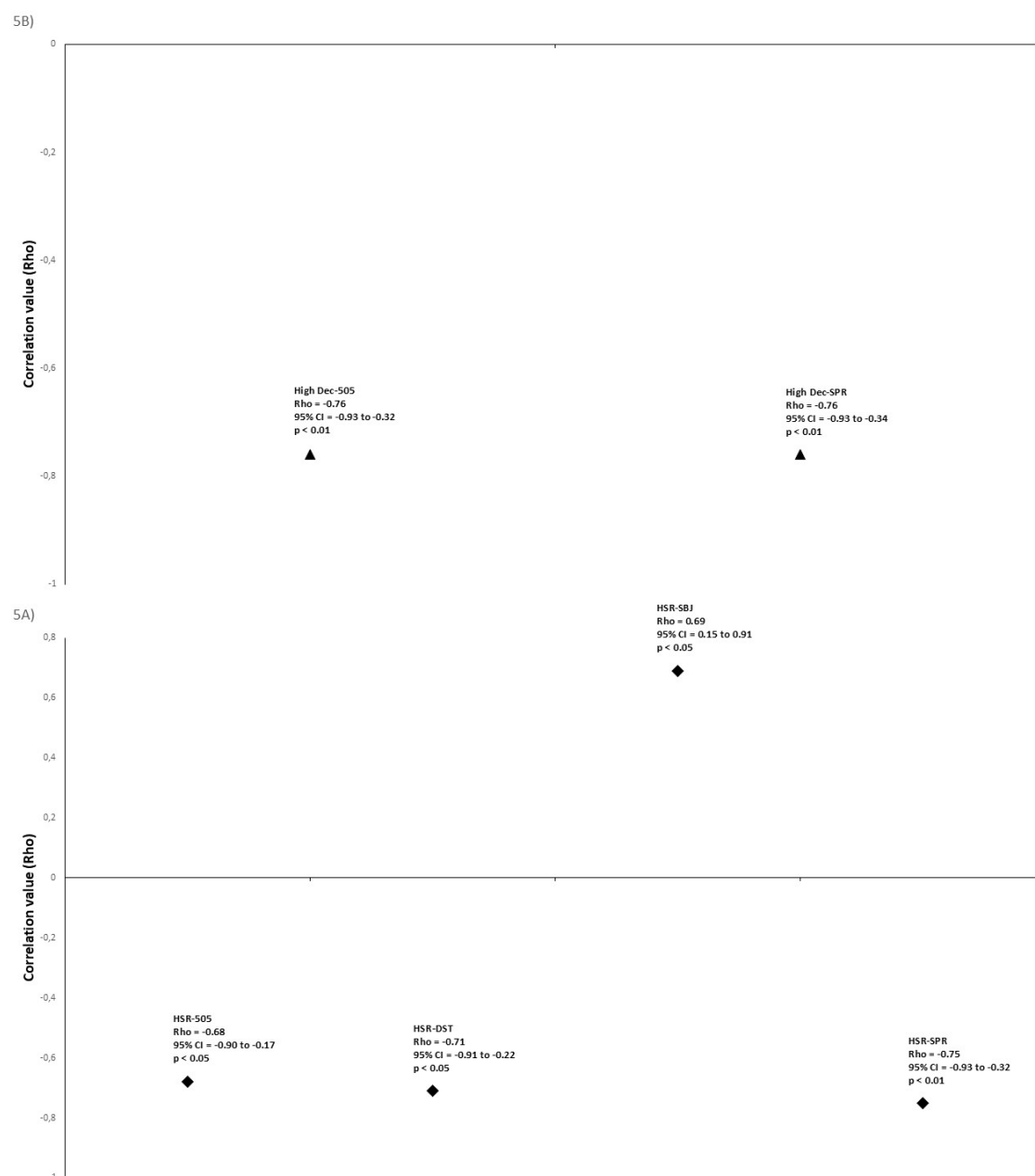


Figure 5. Magnitudes of correlations between the variables HSR with the 505, DST, SBJ, and SPR tests (5A) and High-Dec with the 505 and SPR tests for FT1 class players (5B). *HSR = high-speed running; High Dec = high-intensity decelerations; 505 = 505 test; DST = dribbling speed test; SBJ = standing broad jump; SPR = sprint test; Rho = Spearman's correlation; CI = Confidence Intervals.*

4. Discussion

Intending to expand scientific knowledge on women's CP football, the objectives of this research were to describe the activity limitations and physical responses in official competition among international-level female football players

with CP across different sport classes and to analyze the association between activity limitation tests and physical responses in competition for all players as well as within each profile. The overall findings from this study revealed that, for all players combined, a higher level of activity limitation tests is associated with a reduction in physical

responses during competition. Similarly, within each sport class, results indicate that for FT1 and FT2 players, a moderate to very high association exists between activity limitation tests and physical responses in competition.

While relationships between activity limitation and physical responses have been previously studied in men's CP football (Reina et al., 2020; Reina et al., 2021), this study uniquely focuses on female CP football players and explores whether possible relationships between the impact of the impairment on physical testing and physical responses in competition which are consistent across all sport classes. The analysis of all players found that greater limitations in vertical and horizontal jumping capacity were associated with lower physical responses in competition, especially in high-intensity variables (e.g., explosive distance, MSR, HSR, Vel_{max} , High-Acc, and High-Dec). In conventional football, improving vertical and horizontal jumping power is essential, as it correlates with specific actions in matches (Gathercole et al., 2015), which may explain why players with greater limitations in jumping ability exhibited lower physical responses in competitive variables. Additionally, greater limitations in the split jumps, 505, DST, and sprint tests were associated with a reduced ability to accelerate, decelerate, and reach higher speeds in competition. These results

also align with previous studies in men's CP footballers, where those with higher activity limitations demonstrated lower responses in high-intensity actions during international-level matches (Reina et al., 2020). As discussed earlier, high-intensity and short-duration actions are critical in football since they often precede scoring, defending, or other relevant gameplay actions (Faude et al., 2012). Given that most tests used in this study (i.e., CMJ, SBJ, split jumps, 505, DST, and sprint) appear to be associated with physical responses relevant to competitive performance, these tests would meet the criteria for activity limitation assessment specific to the classification process in women's CP football (Tweedy et al., 2014). However, contrary to findings in men's CP football, which revealed low associations between coordination tests and some physical responses in competition (Reina et al., 2021), the coordination test (SS) in this study of female players showed no associations with any physical response variable in competition. This discrepancy highlights the need to investigate whether this type of coordination test is relevant for classification, particularly in the women's category, and to understand the reasons behind the absence of associations (e.g., sample characteristics, type of impairment, proportion of players with coordination impairment, contextual factors or types of tests used).

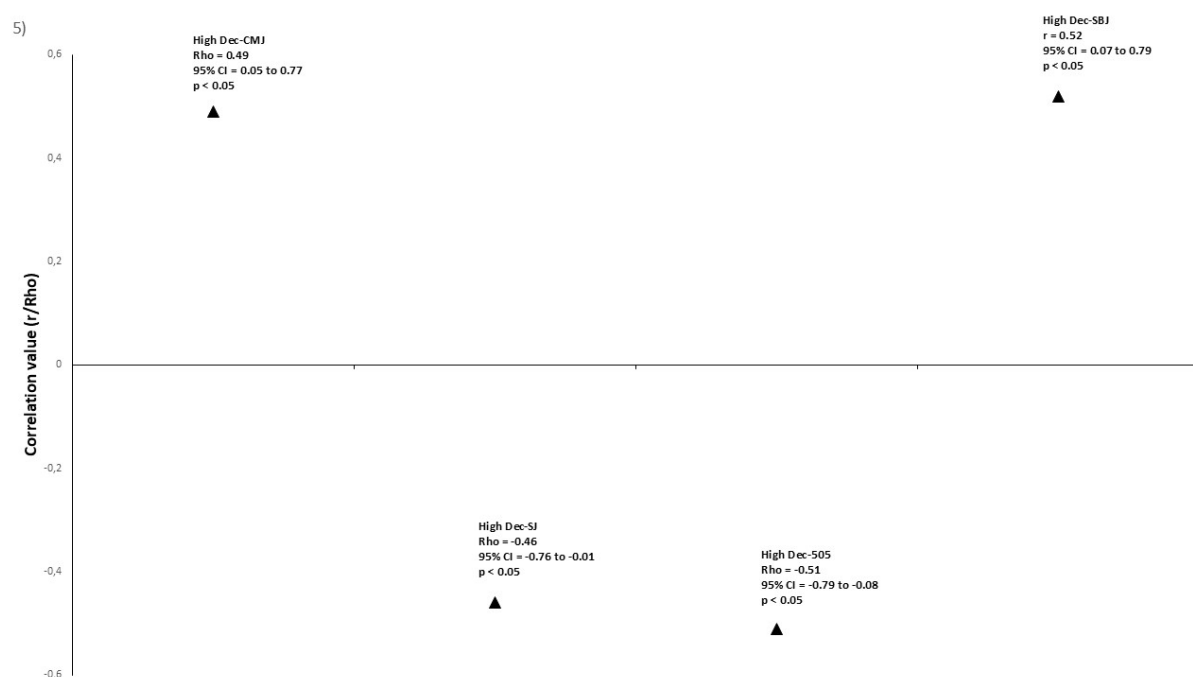


Figure 6. Magnitudes of correlations between high-intensity decelerations with the CMJ, SJ, 505, and SBJ tests for FT2 class players. *High Dec* = high-intensity decelerations; *CMJ* = countermovement jump; *SJ* = split jump; *505* = 505 test; *SBJ* = standing broad jump; *r* = Pearson's correlation; *Rho* = Spearman's correlation; *CI* = Confidence Intervals.

Considering that activity limitation among female players with CP varies significantly by sport class (Henríquez et al., 2024), in addition to examining the association between activity limitation and physical responses in competition for all players, it is essential to analyze impairment-specific relationships, as has been suggested in previous studies with men's CP footballers (Reina et al., 2020; Reina et al., 2021). This study observed significant correlations for FT1 players between vertical and horizontal jumping ability and physical responses in competition. FT1 players also displayed significant high-to-very-high associations in CODA tests or acceleration capacity with high-intensity physical response variables in competition (i.e., explosive distance, Vel_{max} , HSR, and High-Dec). Conversely, no

association between coordination tests and physical responses during competition was found. Based on these associations, the most specific capacities to evaluate activity limitation in FT1 are vertical and horizontal jumping ability, CODA, and accelerations. However, FT1 players showed more associations between physical competition responses and horizontal jumping (i.e., SBJ correlated significantly and strongly with explosive distance, HSR, and Vel_{max}) than vertical jumping (i.e., CMJ showed a strong correlation with MSR). This stronger association between competition physical responses and horizontal jumping ability compared to vertical may be explained by several factors; on one hand, horizontal forces have been shown to play a greater role than vertical forces in specific football actions

such as running, sprinting, changing direction, accelerating, and decelerating (Kugler & Janshen, 2010; Los Arcos et al., 2017), potentially explaining the higher association of the SBJ test compared to the CMJ in FT1 players. Moreover, Reina et al. (2018) reported that horizontal jumps involve the ability to generate force, power, or adequate coordination between upper and lower limbs when jumping, and likely require greater stabilization in braking than vertical jumps. Considering that many actions in football require high stability when braking and that many of the physical responses analyzed in this study are preceded or followed by braking stabilization actions, this may explain the stronger association of physical responses during competition with the SBJ (horizontal jump). These results highlight that perhaps horizontal jump tests may be more pertinent for FT1 female CP football players than vertical jumps within the classification process (Reina et al., 2018). This idea is reinforced by other studies showing horizontal force capacity is more related than other abilities to change of direction ability (Reina et al., 2015) or sprinting (Yanci et al., 2014), both highly relevant in football. On the other hand, the lack of association between coordination tests and physical responses in FT1 players may also be explained by the impairment level of FT1-class players. Another possible reason could be the greater

motor impairment observed in women practicing this discipline, given that many are novice participants with less sporting and physical experience compared to men. These confounding variables might influence the final outcome associated with a selective motor control test, such as coordination tests. Given that a greater limitation in jumping ability (mainly in horizontal jumping), change of direction, and acceleration is associated with lower performance in short-duration and high-intensity actions during competition in female CP players, it seems that CMJ, SBJ, CODA, and sprint tests may have high specificity in those allocated in the FT1 sport class, while coordination tests suggest to be primarily used for eligibility rather than for classification or class assignment. In addition, these results could also be useful for coaches and physical and conditioning specialists when planning their training sessions, allowing them to tailor their physical programs more specifically to the most influential activity limitation capacities.

Regarding FT2 players, the results obtained in this study showed a high association between jumping ability tests (i.e., vertical and horizontal), the split jumps and CODA tests, or the sprint with various physical response variables in competition. However, the tests that showed the most associations with physical response variables in competition were the CMJ (moderate-high

correlations with explosive distance, HSR, Vel_{max} , High-Acc) and especially the split jumps (moderate-high correlations with total and explosive distances, Vel_{max} , Mod-Acc, High-Acc, High-Dec). In male CP footballers, it was observed that players with unilateral spasticity (e.g., FT7 in the former classification profiles) with greater limitations in horizontal jumping ability were associated with a lower capacity to perform high-intensity accelerations (Reina et al., 2020). However, in this study, more associations between vertical jumps and physical responses were found in the FT2 class, contrasting with the findings for the FT1 class. According to the IFCPF (2024) classification regulations, FT2 players have better control when linking forward and lateral actions on both the dominant and non-dominant sides (horizontal axis) compared to FT1 players. This may explain the lower association between horizontal jump capacity and physical responses in competition. Additionally, performance in vertical jump is mainly related to a higher capacity for force development in all lower limb joints (Maulder et al., 2006; Vanezis & Lees, 2005), which could explain the greater limitation in vertical jump height in FT1 compared to FT2 players (IFCPF, 2024). FT1 players have limited ankle and hip extension during propulsion (Roldan et al., 2022), an aspect that FT2 players can compensate with a reduced dorsiflexion and knee extension,

with greater pelvic rotation capacity (Runciman et al., 2016). On the other hand, while no correlations were observed for FT2 players between side-stepping and physical responses in this study, a similar result to that found for FT1-class and contrary to the results obtained by Reina et al. (2021) in male CP footballers, FT2 players with greater limitations in SJ showed lower overall performance in physical response variables in competition (i.e., split jumps correlated with total and explosive distances, Vel_{max} , Mod-Acc, High-Acc, High-Dec). The split jumps test requires rapid cyclic alternating movements in the lower limbs (Beckman & Tweedy, 2009), which could explain why FT2 players with lower capacity to perform these movements show lower physical performance in competition (IFCPF, 2024; Peña-González et al., 2021). Hence, this sport class has limited fluidity in repetitive movement coordination due to the impact of lower limb asymmetry. Based on these results, it seems that in women's football players with CP with moderate involvement (i.e., FT2), the most relevant tests would be the SBJ, 505, sprint, and especially the CMJ and split jumps, showing the strongest associations with physical performance in competition.

Contrary to the results obtained in the FT1 and FT2 classes, for these players belonging to the FT3 class, only a significant and negative association was found between

the CMJ and total distance. No significant correlations were found between the other activity limitation tests and physical responses in competition. The results obtained in the present study differ from those found in a study conducted in the male modality (Reina et al., 2020), where significant associations were found in players with low impairment levels. Specifically, in the Reina et al. (2020) study, it was observed that male CP players with better results in the SJ achieved higher maximum speed, that greater jump capacity was associated with greater ability to accelerate/decelerate, and that higher acceleration capacity correlated with longer distances covered at high intensity (Reina et al., 2020). In conventional football, it has been stated that the individual interaction space is crucial for exhibiting maximum potential in high-intensity actions. In this regard, Castillo et al. (2020) found associations between players who performed speed tests and their physical responses with an individual interaction space of 200 m² but not with 100 m² per player. Given that the individual interaction space in female CP football is 108 m² per player, it is possible that FT3 players (i.e., lower level of impairment) were unable to express their maximum physical potential during competition. This aspect may explain the lack of associations between activity limitation and physical responses in competition. In addition, this point could be interesting to focus for

coached because it is possible that FT3 players need analytic training to explore their maximum velocities. On the other hand, the competition regulations (IFCPF, 2023) limit each team to having only one FT3 player (i.e., lower physical impairment) on the field of play. On one hand, this regulatory limitation prevents many FT3 players from participating in the competition ($n = 4$ in our study). On the other hand, it could be that contextual factors, such as the position or the specific roles of these players may influence their physical responses during competition.

This study has certain limitations that must be considered with caution when interpreting the findings. Even though the sample size was considerable regarding the number of women participants with CP, the smaller number of participants in each profile constrained the analysis of sport class associations. This issue is common in para-sport research due to the specific characteristics of the population studied (Coswig et al., 2019). The limited representation of players in the FT3 category constitutes a significant practical constraint that could have affected the obtained results, although competition rules limit each team to only having one FT3 player in the field of play (IFCPF, 2023). Therefore, although this aspect may limit the generalizability of the correlation results, it is worth mentioning that the players in this study represent 77.78% of the players who participated in the

highest-level international female CP football tournament. To address this, future efforts should aim to replicate the study with a larger sample as women's participation in international championships continues to increase, together with the quality of the competition and the level of the CP footballers. Despite these limitations, it is important to highlight that this study includes nearly all international players currently active in this team para-sport.

5. Practical Applications

The results of this study could provide relevant information for the development of evidence-based classification processes, in alignment with the new classification code. Furthermore, they may help refine the classification system by considering the differences in the female modality compared to the existing evidence in male athletes. This could lead to a better understanding of the impact of impairments on activity limitations and their relationship with competitive performance. Therefore, this knowledge could contribute to optimizing classification protocols and class allocation in female PC football players.

6. Conclusions

Across all players, most tests (except the coordination tests) were associated with physical responses relevant to competitive performance. The results of this study for all players show that greater limitations in the

tests were associated with lower physical responses in competition, especially in high-intensity variables. A significant association was found between horizontal jump capacity, CODA, and sprint with high-intensity competition variables in women's football players with CP of FT1 class. In FT2 class, an association was observed between CODA and acceleration capacity with specific high intensity acceleration/decelerate variables, especially between vertical jump capacity and coordination with high-intensity competition variables. In contrast, players with lower impairment (i.e., FT3) showed minimal associations between these variables. These findings could be highly relevant for CP football classification teams, providing crucial insights when selecting activity limitation tests for assigning sport classes. The coordination tests used, although requiring inter-limb coordination, might be more related to eligibility rather than performance, as they are conducted in a static context, whereas gameplay occurs in a dynamic environment. These results should be interpreted with caution because of the limited number of CP players in the FT3-class.

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