Training practices of male and female para athletics throwers: from developmental to world-class levels

Prácticas de entrenamiento de lanzadores de para atletismo masculino y femenino: desde el nivel de desarrollo hasta el de clase mundial

Authors

Exal Garcia-Carrillo [1,2]
Bruno Silva [3]
Nikolaos Zaras [4,5]
Rodrigo Ramirez-Campillo [6,7]

[1]Universidad Bernardo O'Higgins, Santiago, Chile
[2]Universidad de Los Lagos, Osorno, Chile
[3]Instituto Politécnico de Viana do Castelo, Portugal
[4]Democritus University of Thrace, Greece
[5]University of Nicosia, Cyprus
[6]Universidad Andres Bello, Santiago, Chile
[7]Universidad de Tarapacá, Arica, Chile

Corresponding author:
Exal Garcia-Carrillo
exal.garcia@gmail.com

How to cite in APA

Garcia-Carrillo, E., Silva, B., Zaras, N., & Ramirez-Campillo, R. (2025). Training practices of male and female para athletics throwers: from developmental to world-class levels. *Retos*, *66*, 182–191. https://doi.org/10.47197/retos.v66.110399

Abstract

Introduction: A better understanding of Para Athletics throwers (PAT) training practices is in line with the development and optimization of their training programs, able to produce peak performances across varying competitive levels.
Objective: Investigate the PAT training practices.
Methodology: Male (n=42) and female (n=18) PAT completed an online questionnaire regarding descriptive characteristics (e.g., age, height, weight, throwing event) and training practices (e.g., experience, duration, frequency, strength and conditioning). PAT were classified into world-class, international, national, or developmental level, and thereafter re-classified (to increase statistical power, i.e., Mann-Whitney U test) into world/international or national/developmental.
Results: Most males (92.86%) and all females performed strength and conditioning at the gym, with no differences in gym training frequency between sexes (p=0.221). World-class PAT had significantly more years of experience compared to other levels (p<0.001), though there were no differences in the frequency (p=0.400) or duration (p=0.502) of throwing sessions. Males trained for longer session durations than females (p=0.001), while training frequency did not differ between them (p=0.075).
Conclusions: While elite athletes had greater training experience compared to lower-competitive levels, there were no differences in training frequency or duration across competitive levels. However, when comparing sexes, males generally trained for longer durations per session than females, but training frequency did not differ between them. Most training characteristics, including strength and conditioning practices and throwing training, were similar between sexes and across competitive levels. These findings emphasize the need for individualized training programs to optimize PAT performance.

Keywords

Athletic performance; disabled persons; para-athletes; sports for persons with disabilities; track and field.

Resumen

Introducción: Una mejor comprensión de las prácticas de entrenamiento de lanzadores de para atletismo (LPA) va de la mano con el desarrollo y optimización de programas de entrenamiento capaces de producir máximo rendimiento en diferentes niveles competitivos.
Objetivo: Investigar las prácticas de entrenamiento de LPA.
Metodología: LPA masculinos (n=42) y femeninos (n=18) contestaron un cuestionario sobre características descriptivas (p. ej., edad, altura, peso, evento de lanzamiento) y prácticas de entrenamiento (p. ej., experiencia, duración, frecuencia, preparación física). Los LPA se clasificaron en niveles: clase mundial, internacional, nacional o desarrollo. Posteriormente se reclasificaron (para aumentar el poder estadístico con la prueba U de Mann-Whitney) en mundial/internacional o nacional/de desarrollo.
Resultados: La mayoría de hombres (92.86 %) y todas las mujeres realizaron preparación física en gimnasio, sin diferencias en frecuencia de entrenamiento entre sexos (p=0.221). Los atletas de élite tuvieron mayor experiencia comparados con otros niveles (p<0.001). No hubo diferencias en frecuencia (p=0.400) o duración (p=0.502) en los entrenamientos de lanzamiento. Los hombres tuvieron entrenamientos más largos que las mujeres (p=0.001), aunque la frecuencia fue similar entre ambos (p=0.075).
Conclusiones: Si bien los atletas de élite tuvieron más experiencia que los de menor nivel, no hubo diferencias en frecuencia o duración del entrenamiento. Los hombres entrenaron más tiempo que las mujeres, sin diferencia en frecuencia de entrenamiento. La mayoría de las características de entrenamiento, incluyendo preparación física y lanzamientos, fueron similares entre sexos y niveles. Estos resultados resaltan la importancia de programas de entrenamiento individualizados para maximizar el rendimiento de LPA.

Palabras clave

Deporte adaptado; deporte paralímpico; deportes para personas con discapacidad; para atletas; rendimiento atlético.

Introduction

Para Athletics throwing events (i.e., shot-put, discus, javelin, and club throwing) (International Paralympic Committee, 2024) becomes a perfect example of the impressive athleticism and commitment demonstrated by athletes with physical, intellectual, and visual impairments. Despite facing significant challenges, Para Athletics throwers (PAT) have consistently demonstrated remarkable athletic achievements, as evidenced by the steady linear progression in performance over the years (Garcia-Carrillo, Ramirez-Campillo, et al., 2024; Rodríguez Macías et al., 2022). However, PAT face significant challenges which affect not only their competition results (e.g., discrimination, particularly of females) (Oggero et al., 2021) but their daily training routines and practices as well (Cavaggioni et al., 2021).

In addition to the daily barriers that PAT have to overcome, scientific evidence regarding their training practices is lacking. Training is designed with the manipulation of several prescription variables, such as intensity, volume, frequency, duration, and rest intervals (DeWeese et al., 2015). These parameters are shifting during each training phase. For example, during the preparation phase, training load, frequency and duration are expected to be higher compared to the tapering phase (Garcia-Carrillo & Ramirez-Campillo, 2020). Non-disabled throwers reported 9-12 training sessions per week, including resistance training, throwing training, plyometric, and sprint training, while training volume and intensity shifting according to the goal of each training phase (Anousaki et al., 2021; Zaras et al., 2016). However, is unclear whether PAT follows similar training practices.

Non-disabled throwers include a large volume of resistance training to increase muscle strength, power and throwing performance (Martínez-García et al., 2021; Terzis et al., 2008). In contrast, PAT might experience problematic access to resistance training facilities, potentially affecting their involvement in resistance training programs (Rodríguez Macías et al., 2022). For non-disabled throwers, 3 to 6 training sessions per week seems to provide adequate stimulus to increase strength and power (Anousaki et al., 2021; Kraemer & Ratamess, 2004). Resistance training is essential for PAT, as the sport carries a high prevalence of injury risk factors (DeWeese et al., 2015; Garcia-Carrillo, Silva, et al., 2024). Previous studies showed that PAT athletes are exposed to a high rate of shoulder tendinopathies and shoulder tendon ruptures mainly caused by the repetitive high-velocity throws during training conditions (Cools et al., 2015; Garcia-Carrillo, Silva, et al., 2024; Kettunen et al., 2011). Resistance training may increase strength, muscle mass and mobility leading to a potential reduction of injuries (Suchomel et al., 2016). However, the exact training frequency and duration of resistance training for PT is not clear. Moreover, a recent study has shown that among a non-disabled group of well-trained throwers, their competitive level was not a decisive factor for program design, at least at the beginning of the preparation training phase. Specifically, no significant differences were found for physical fitness attributes (i.e., sprinting, jumping and handgrip strength) as well as for body composition between national, international and international medalist athletes (Garcia-Carrillo, Gallardo-Fuentes, et al., 2024). Whether the competitive level may affect the training structure of PAT is yet to be investigated. Coaches and PAT may use this information as a tool to design more effective and individualized training programs. Therefore, the primary objective of this study was to describe the training practices of PAT during their annual training cycle. This study specifically aimed to: 1) Characterize the training practices of PAT, including training frequency, training duration, and modalities; and 2) Investigate the influence of sex and competitive level (elite vs. regional) on these training practices.

Method

The current cross-sectional study aimed to investigate the training practices of PAT and assess the influence of sex and competitive level on these practices by using an online questionnaire to gather detailed information on their training routines, training experience, and other relevant aspects of their sport.

Participants

A total of 60 PAT (male=42, female=18) aged ≥ 18 years, with ≥ 1 year of training experience, provided written informed consent prior to taking part in the study (31 [IQR: 23-42] years, 85 [IQR: 61-101] kg, 173 [IQR: 164-180] cm). Descriptive statistics for participant's characteristics are presented in Table 1.

Participants were excluded from the analysis in case of providing incomplete responses and those who did not provide written informed consent. Athletes' competitive levels were categorized (McKay et al., 2022) based on their self-reported training and competition history: i) Developmental level (DL): Regularly train and compete at local events; ii) National level (NL): Participate up to national-level competitions; iii) International level (IL): Participate up to international-level competitions; iv) World-class level (WL): Medaled at Paralympic Games or World Championships.

Table 1. Descriptive statistics for participant's characteristics

		Min	Max	Median (IQR)	U	*z*-value	*p*-value
Age (years)	Total	18	55	31.0 (23.0-42.0)	297	-1.31	0.196
	Male	19	50	32.0 (25.2-41.0)			
	Female	18	55	24.0 (21.2-40.7)			
Weight (kg)	Total	37	123	85.0 (61.7-101.0)	131	-3.99	<0.001*
	Male	37	123	90.0 (82.5-107.2)			
	Female	42	106	61.5 (53.7-75.0)			
Height (cm)	Total	100	195	173 (164-180)	139	-3.86	<0.001*
	Male	100	195	175 (171-181)			
	Female	118	179	162 (156-169)			

CI: confidence interval, IQR: Interquartile range, U: Mann-Whitney U statistic, * = p<0.001, denoting differences between male and female.

Instrument

Data collection was conducted using a custom-designed questionnaire administered by Google Forms, which was made available in English, Spanish, and Portuguese languages. The questionnaire, which was adapted to PAT from a previous study (Matos et al., 2021) was designed by a team of experts including an experienced track and field throwing coach, an experienced researcher in the field of throwing, and a para sport researcher. The instrument was then tested in a small group (3 PAT) before its final application, after receiving feedback, the following improvements were made: adding a question regarding the main throwing event practiced and explicitly indicating the unit of measurement for each variable. It was then distributed to PAT (or their coaches) by the main author (E.G.C.) who is currently involved in Para Athletics throwing in Chile, utilizing different communication methods (e.g., in person; email; social networks). The questionnaire remained open for responses during a 9-month period (November 2022 to July 2023).

Data analysis

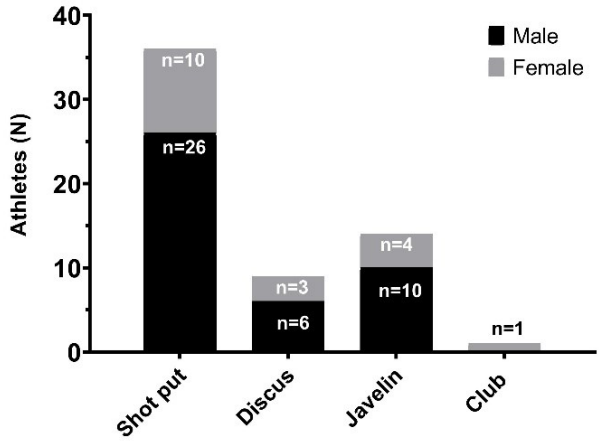
The Shapiro-Wilk test revealed that the data were not normally distributed. Thereafter, descriptive statistics were used including median values with interquartile range (IQR). The Mann-Whitney U test was used to assess differences between groups. An α level of ≤0.05 was used for all statistical tests. All data analyses were performed using GraphPad Prism version 8.0.1 for macOS X (GraphPad Software, San Diego, CA, USA).

Results

The distribution by country and sex was as follows: Chile (10 males, 3 females), Colombia (6 males, 2 females), Panama (6 males, 2 females), Argentina (1 male, 4 females), Brazil (2 males, 0 females), Costa Rica (1 male, 0 females), Ecuador (2 males, 1 female), Guatemala (1 male, 0 females), Mexico (1 male, 1 female), Paraguay (0 males, 1 female), Peru (1 male, 0 females), Spain (5 males, 1 female), United Kingdom (3 males, 1 female), Netherlands (1 male, 0 females), Romania (1 male, 0 females), United States (0 males, 1 female), Canada (1 male, 0 females), Australia (1 male, 0 females), and Moldova (0 males, 1 female). In total data from 60 participants from the following sport classes were analyzed including male (n = 42, 70%) and female (n = 18, 30%) PAT: F55 (5 males, 2 females), F57 (4 males, 2 females), and F54 (3 males, 2 females). Other age groups represented included F40 (3 males, 2 females), F46 (2 males, 2 females), F64 (2 males, 2 females), F20 (3 males, 1 female), F12 (3 males, 0 females), F56 (3 males, 0 females), F33 (2 males, 1 female), F35 (1 male, 1 female), F37 (1 male, 1 female), F34 (1 male, 1 female), F38 (1 male, 1 female), and 14 additional classes with only 1 male participant each: each: F42, F62, F41, F11, F44, F36, F63, F32, F51, F52, F53, F58, F59, and F60. Their ages ranged from 18 to 55 years, with a

median age of 31 (IQR 23-42) years (Table 1). Males were significant heavier and taller compared to females PAT (Table1).
Originally, participants were divided into four categories: WL (n = 11), IL (n = 28), NL (n = 19), and DL (n = 2). However, due to the low number of participants, for statistical purposes, categories were re-grouped into two: WL-IL and NL-DL categories. Their main throwing event is represented in Figure 1. PAT reported varying levels of throwing experience, ranging from 1 to 30 years, with a median of 6 (IQR 3.0 - 8.3) years (Table 2). Most males (n=31) reported ≤ 8 years of experience, while most females (n=10) reported ≤ 6 years.

Figure 1. Main throwing event of Para Athletics throwers.



Training practices according to sex

Frequency of training is depicted in Table 2. Most males (n=22) reported ≤ 3 weekly throwing training sessions, while most females (n=13) reported ≤ 4 weekly throwing training sessions. Throwing training sessions for male athletes typically lasted between 90-100 minutes/session (14.29%), 120-130 minutes/session (33.34%), and 180 minutes/session (14.29%). On the other hand, females throwing sessions lasted 50-60 minutes/session (38.89%), and 120-130 minutes/session (22.22%). Other less-prevalent training session durations for both males and females are depicted in Table 2.

Strength and conditioning practices are presented in Table 2. Most males (92.86%) and females (100%) engaged in gym workouts (in addition to their throwing training). Males trained in the gym 3-4 times per week (45.24%), and 5-6 times per week (33.34%). Females (61.11%) trained 3-4 times per week, and 5-6 times per week (22.22%). Males completed 6-7 hours/week of gym training (26.19%), and >10 hours/week (16.67%), while females trained 2-3 hours per week (44.44%).

Both males (80.95%) and females (77.78%) included medicine ball throws in their strength and conditioning training routines and this was performed 1-3 times a week with a median of 45 (IQR 10-145).

Table 2. Para Athletics throwers characteristics according to competitive level and gender

	Category	Sex of participants	
		Male (n=42)	Female (n=18)
		n (%)	n (%)
Throwing Sessions per Week	1 session	3 (7%)	0
	2 sessions	3 (7%)	3 (17%)
	3 sessions	16 (38%)	6 (33%)
	4 sessions	7 (17%)	4 (22%)
	5 sessions	5 (12%)	1 (6%)
	6 sessions	7 (17%)	2 (11%)
	> 6 sessions	1 (2%)	2 (11%)
Throwing Session Duration (Minutes)	Up to 30 min	2 (5%)	3 (17%)
	40-45 min	5 (12%)	2 (11%)
	50-60 min	5 (12%)	7 (39%)
	70-75 min	2 (5%)	0

	90-100 min	6 (14%)	0
	120-130 min	14 (33%)	4 (22%)
	150 min	2 (5%)	0
	180 min	6 (14%)	2 (11%)
Experience in Para Throwing (Years)	1-2 years	9 (21%)	2 (11%)
	3-4 years	7 (17%)	4 (22%)
	5-6 years	5 (12%)	4 (22%)
	7-8 years	10 (24%)	4 (22%)
	9-10 years	6 (14%)	1 (6%)
	> 10 years	5 (12%)	3 (17%)
Gym Training Sessions per Week	No gym training	3 (7%)	0
	1-2 sessions	5 (12%)	3 (17%)
	3-4 sessions	19 (45%)	11 (61%)
	5-6 sessions	14 (33%)	4 (22%)
	> 6 sessions	1 (2%)	0
Weekly Gym Training Hours	No gym training	3 (7%)	0
	2-3 hours	8 (19%)	8 (44%)
	4-5 hours	7 (17%)	3 (17%)
	6-7 hours	11 (26%)	3 (17%)
	8-9 hours	6 (14%)	3 (17%)
	> 10 hours	7 (17%)	1 (6%)

Training practices according to competitive level

Table 3 presents age, training experience, and training characteristics of PAT grouped by competitive level (WL-IL and NL-DL). The WL-IL group had a median age of 33 (IQR 25 - 45) years, being older than the NL-DL group (p=0.017). The HL PAT reported more years of training experience with a median of 8 (IQR 6 - 10) years. In terms of the number of throwing training sessions per week (TTS), WL-IL trained 4 (IQR 3 - 5) while NL-DL trained 3 (IQR 3 - 4.5) days per week, respectively, with no statistically significant differences (p=0.400). Throwing training session duration (TTD; minutes/session) in WL-IL and NL-DL athletes was 90 (IQR 60 - 120) vs 120 (IQR 45 -125) min/session, respectively, although without significant differences between groups (p=0.502).

Table 3. Comparative metrics of WL-IL and NL-DL performance Para Athletics throwers

	WL-IL	NL-DL	U	*z*-value	*p*-value
Athletes	n = 39	n = 21			
Age (years)	33 (25.0-45.0)	26 (19.0-33.5)	254.5	-2.40	0.017*
Weight (kg)	89 (71.5-109.0)	84 (56.0-87.0)	281.5	-1.98	0.049*
Height (cm)	173 (165-180)	172 (155-175)	334.5	-1.16	0.250
Exp (years)	8 (6.0-10.0)	3 (2.0-5.0)	133.5	-4.29	0.001**
TTS (days/week)	4 (3.0-5.0)	3 (3.0-4.5)	354.5	-0.88	0.400
TTD (min/session)	90 (60.0-120.0)	120 (45.0-125.0)	365.5	-0.69	0.502

Exp: training experience; TTS: throwing training sessions; TTD: throwing training duration; *: $p<0.05$; **: $p<0.001$; DL: developmental level; NL: national level; IL: international level; U: Mann-Whitney U statistic; WL: world-class level.
Note: Data are presented as median (interquartile range).

The same analyses but comparing male and female PAT demonstrated significant differences in weight and height, with males showing higher values in both parameters. The comparative metrics for WL-IL and NL-DL PAT, separated by sex, are presented in Table 4.

Table 4. Para Athletics throwers characteristics according to competitive level and gender

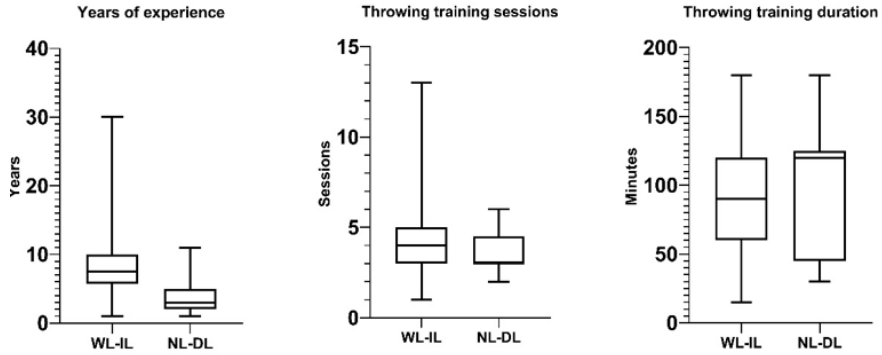
	Level#	Gender¶	Median (IQR)	U	*z*-value	*p*-value
Age (years)	WL-IL	Male	34.0 (26.0-45.0)	130.50	-0.960	0.337
		Female	28.5 (23.0-44.3)			
	NL-DL	Male	28.0 (22.0-34.0)	23.50	-1.681	0.093
		Female	18.5 (18.0-34.8)			
Weight (kg)	WL-IL	Male	104.0 (79.0-113.0)	59.00	-3.136	0.001**
		Female	70.5 (58.8-78.8)			
	NL-DL	Male	85.0 (84.0-91.0)	10.00	-2.729	0.006*
		Female	52.5 (49.5-65.5)			
Height (cm)	WL-IL	Male	180.0 (170.0-183.0)	59.50	-3.127	0.001**
		Female	164.5 (160.0-170.0)			
	NL-DL	Male	174.0 (170.0-176.0)	14.50	-2.378	0.017*
		Female	154.5 (142.0-165.5)			
Exp (years)	WL-IL	Male	8.0 (6.0-10.0)	126.50	-1.087	0.284
		Female	7.0 (5.3-9.3)			
	NL-DL	Male	3.0 (2.0-5.0)	34.50	-0.826	0.409
		Female	4.0 (2.5-6.5)			

TTS (days/week)	WL-IL	Male Female	3.0 (3.0-5.0) 4.0 (3.0-6.0)	121.50	-1.260	0.221
	NL-DL	Male Female	3.0 (3.0-5.0) 3.0 (2.0-3.3)	23.50	-1.780	0.075
TTD (min/session)	WL-IL	Male Female	90.0 (60.0-120.0) 60.0 (45.0-120.0)	115.50	-1.435	0.159
	NL-DL	Male Female	120.0 (50.0-130.0) 60.0 (37.5-135.0)	31.50	-1.087	0.277

Exp: training experience; TTS: throwing training sessions; TTD: throwing training duration; *: $p<0.05$; **: $p<0.001$; #: DL: developmental level; NL: national level; IL: international level; U: Mann-Whitney U statistic; WL: world-class level.
¶: WL-IL n=39 (male n=27, female n=12), NL-DL n=21 (male n=15, female n=6).
Note: Data are presented as median (interquartile range).

See Figure 2 for a visual comparison of experience, throwing training sessions, and throwing training duration between the aforementioned competition levels.

Figure 2. Boxplots comparing years of experience, throwing training sessions, and throwing training duration variables between world-class/international level (WL-IL) and national/developmental level (NL-DL) Para Athletics throwers.



Discussion

PAT often miss training sessions due to several barriers that directly affect their access in training facilities. Therefore, it was the aim of the study to investigate the training practices of PAT during their annual training cycle and explore the role of sex and competitive level on these training practices. The main finding of the study was that the majority of male and female PAT followed 3 training sessions per week for throwing training and strength and conditioning. In addition, the majority of male PAT had greater training duration both in throwing and gym sessions compared to the majority of female PAT. Gym training frequency was 3-4 days, which was similar for most males and females. Additionally, medicine ball throw training was also similar for the majority of both sexes. Regarding the throwing training experience, WL-IL PAT were the oldest among the participants whilst they had the higher throwing training experience compared to their NL-DL counterparts. These results suggest that training frequency and duration is not majorly affected in male PAT whilst in female PAT training duration is shorter. WL-IL PAT are more experienced and older, but these do not affect training frequency, duration, and gym training sessions.

The main finding of the study was that both male and female PAT had a training frequency of 3 days per week in throwing and gym training sessions. According to the authors knowledge, this is the first study to investigate the throwing and gym training frequency in PAT. Previous studies in non-disabled throwers have shown that throwing training frequency was approximately 4-5 training session per week in elite throwers (Anousaki et al., 2021) and 3 training sessions per week in well trained throwers (Kyriazis et al., 2009; Zaras et al., 2016). In addition, the gym training frequency for non-disabled throwers was 3-4 sessions per week (Kyriazis et al., 2009; Zaras et al., 2016), similar to the findings of the current study. It seems that there is a consensus regarding the training frequency for both throwing and resistance training, leading to the conclusion that increased technical patterns and muscle strength/power are essential for PAT to enhance competitive throwing performance and reduce the injury rate. This finding is further reinforced by the weekly gym duration. More specific, the majority of

male PAT spends approximately 6-7 hours per week in gym training although females spend 2-3 hours per week. Moreover, the majority of male PAT spends 120-130 min per session in throwing training. These training duration times might also be affected by the physical impairments of the athletes. For example, most PAT included in the study were shot-put throwers (60%). In shot-put there are time consuming parameters like the time to warm-up, the binding of the athlete in the sitting position (for seated throwers) or the number of throws performed during training. Shot-put is also a heavier throwing implement compared to javelin, discus and club, consequently PAT might use higher rest intervals between throws. However, female PAT (38.9%) had a throwing training duration approximately at 50-60 min while the 22.2% had 3 days per week training frequency, similar to male PAT. Therefore, for an effective training program design, it is suggested 3 training sessions per week in both throwing and resistance training sessions with duration of 120 min for males and 60 min for female PAT.

It was noted that medicine ball throws were a common component of training routines among PAT, which allows track and field throwers to mimic the powerful, sequential, and rotational actions that occur during the competitive movement (Ikeda et al., 2009). This aligns with previous evidence demonstrating that medicine ball training can provide greater sport-specific improvements in the upper body (i.e., maximal strength, sport-specific throwing performance) (Garcia-Carrillo et al., 2023). Indeed, medicine ball throws as a ballistic throwing exercise is a common practice in non-disabled throwers aiming to increase whole body power during the year-round training cycle (Kyriazis et al., 2009; Zaras et al., 2016). For PAT, medicine ball is an “easy-to-use” training method which directly increases throwing ability. The results of the study showed that most PAT (males: 80.95%; females: 77.78%) utilize medicine ball throws 1-3 times per week in their training schedule. Consequently, coaches may use this frequency to utilize medicine ball training in PAT.

Comparison analysis between WL-IL and NL-DL performer’s PAT showed that WL-IL were older and had a higher competitive experience compared to NL-DL. However, these differences between groups did not reveal any difference between throwing training sessions per week and throwing training duration. Therefore, other factors might affect the competitive level. A recent study in non-disabled throwers showed that the competitive level is not a limiting factor for training design especially in the early beginning of training (Garcia-Carrillo, Gallardo-Fuentes, et al., 2024). While this was partially attributed to psychological attributes such as self-confidence and lower levels of somatic anxiety in high performers, other factors such as effective coaching, technical mastery, and strategic goal-setting may also play a critical role in enhancing throwing performance during competition. (Hanton et al., 2008). To conclude, it might be hypothesized that similar to non-disabled throwers; PAT may experience the same psychological effects.

The current study has some limitations. The number of PAT included might be small, especially for females, although these athletes were recruited from 19 different countries across the world. Challenges in the recruiting process due to limited accessibility, logistical constraints, and potential social and cultural barriers. Furthermore, women are generally underrepresented within Para Athletics (Dean et al., 2022). Training variables were referred according to the year-round training cycle, thus more research is needed to clarify changes in training variables across different training phases. More research is needed to investigate the training practices of PAT and especially in female PAT. Future directions in PAT research may include making efforts to include more participants and increasing the geographical diversity, and to incorporate a wider range of training variables such as training intensity, training volumes, training modalities, and gym training load.

Based on the findings of this study, coaches should consider implementing specific training adjustments, for example, training programs for male PAT may benefit from incorporating higher training volumes, especially in strength training, given their typically greater muscle mass. Furthermore, coaches should consider adjusting training loads and intensities based on the PAT competitive level. While elite PAT may benefit from higher training volumes and intensities, regional level PAT may benefit from a more gradual progression.

Conclusions

The results of the present study showed some sex-specific and competitive-level specific differences with respect to male and female PAT. Males were taller and heavier than females, and a higher level of competitive sport was associated with an increased number of years spent accumulating training experience. Male PAT usually trained with a throwing frequency of 3 sessions per week, with 120-130 minutes session duration, alongside with 3-4 gym training sessions per week, totaling 6-7 hours, including medicine ball training sessions 1-3 times a week. Female athletes followed a similar training structure but with shorter throwing sessions (50-60 minutes) and less time dedicated to gym training (2-3 hours). Despite these differences, no significant difference was found between sexes for overall training frequency. Furthermore, higher-performing PAT tended to be older and more experienced, but training frequency and duration was not significantly different between competitive levels. These results underscore the necessity of sex-specific and competitive-level-specific training programs in performance optimization. Future research may focus on designing training strategies that contribute to develop higher performance outcomes in PAT.

Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the Universidad de Los Lagos.

Financing

There was no external funding involved in the development of this article.

References

Anousaki, E., Zaras, N., Stasinaki, A.-N., Panidi, I., Terzis, G., & Karampatsos, G. (2021). Effects of a 25-Week Periodized Training Macrocycle on Muscle Strength, Power, Muscle Architecture, and Performance in Well-Trained Track and Field Throwers. *J. Strength Cond. Res.*, *35*(10), 2728-2736. https://doi.org/10.1519/jsc.0000000000004098

Cavaggioni, L., Trecroci, A., Formenti, D., Hogarth, L., Tosin, M., & Alberti, G. (2021). Seasonal Changes in Breathing Pattern, Trunk Stabilization, and Muscular Power in Paralympic Swimmers. *Adapt. Phys. Activ. Q.*, *38*(2), 215-231. https://doi.org/10.1123/apaq.2020-0088

Cools, A. M., Johansson, F. R., Borms, D., & Maenhout, A. (2015). Prevention of shoulder injuries in overhead athletes: a science-based approach. *Braz. J. Phys. Ther.*, *19*(5), 331-339. https://doi.org/10.1590/bjpt-rbf.2014.0109

Dean, N. A., Bundon, A., Howe, P. D., & Abele, N. (2022). Gender Parity, False Starts, and Promising Practices in the Paralympic Movement. *Sociol. Sport J.*, *39*(3), 221-230. https://doi.org/10.1123/ssj.2021-0030

DeWeese, B. H., Hornsby, G., Stone, M., & Stone, M. H. (2015). The training process: Planning for strength–power training in track and field. Part 2: Practical and applied aspects. *J. Sport Health Sci.*, *4*(4), 318-324. https://doi.org/10.1016/j.jshs.2015.07.002

Garcia-Carrillo, E., Gallardo-Fuentes, F., Ramirez-Campillo, R., Carter-Thuillier, B., Thapa, R. K., & Zaras, N. (2024). Evaluation of physical fitness in track and field throwing athletes across different competitive levels. *J. Phys. Educ. Sport.*, *24*(3), 552-559. https://doi.org/10.7752/jpes.2024.03066

Garcia-Carrillo, E., & Ramirez-Campillo, R. (2020). Peaking for the World Para Athletics Championships: Case Study of a World Champion Female Paralympic Shot Putter. *J. Hum. Sport. Exerc.*, *15*(4), S1204-S1213. https://doi.org/10.14198/jhse.2020.15.Proc4.22

Garcia-Carrillo, E., Ramirez-Campillo, R., Thapa, R. K., Afonso, J., Granacher, U., & Izquierdo, M. (2023). Effects of Upper-Body Plyometric Training on Physical Fitness in Healthy Youth

and Young Adult Participants: A Systematic Review with Meta-Analysis. *Sports Med. - Open*, *9*(1), 93. https://doi.org/10.1186/s40798-023-00631-2

Garcia-Carrillo, E., Ramirez-Campillo, R., & Winckler, C. (2024). Scientific production on Para Athletics: A bibliometric review. *Int. J. Disabil. Sports Health Sci.*, *7*(5), 1199-1206. https://doi.org/10.33438/ijdshs.1488551

Garcia-Carrillo, E., Silva, B., Zaras, N., Azocar-Gallardo, J., Yáñez-Sepúlveda, R., & Ramirez-Campillo, R. (2024). Prevalence of sports injuries in Para Athletics throwers - a retrospective cohort study. *Adv. Rehab.*, *38*(3), 7-15. https://doi.org/10.5114/areh.2024.142493

Hanton, S., Neil, R., Mellalieu, S. D., & Fletcher, D. (2008). Competitive experience and performance status: An investigation into multidimensional anxiety and coping. *Eur. J. Sport Sci.*, *8*(3), 143-152. https://doi.org/10.1080/17461390801987984

Ikeda, Y., Miyatsuji, K., Kawabata, K., Fuchimoto, T., & Ito, A. (2009). Analysis of Trunk Muscle Activity in the Side Medicine-Ball Throw. *J. Strength Cond. Res.*, *23*(8), 2231-2240. https://doi.org/10.1519/JSC.0b013e3181b8676f

International Paralympic Committee. (2024). *World Para Athletics rules and regulations 2024*.

Kettunen, J. A., Kujala, U., Sarna, S., & Kaprio, J. (2011). Cumulative incidence of shoulder region tendon injuries in male former elite athletes. *Int. J. Sports Med.*, *32*(6), 451-454. https://doi.org/10.1055/s-0031-1273701

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Med. Sci. Sports Exerc.*, *36*(4), 674-688. https://doi.org/10.1249/01.mss.0000121945.36635.61

Kyriazis, T. A., Terzis, G., Boudolos, K., & Georgiadis, G. (2009). Muscular power, neuromuscular activation, and performance in shot put athletes at preseason and at competition period. *J. Strength Cond. Res.*, *23*(6), 1773-1779. https://doi.org/10.1519/JSC.0b013e3181b3f91e

Martínez-García, D., Chirosa Ríos, L., Rodriguez-Perea, A., Ulloa-Díaz, D., Jerez-Mayorga, D., & Chirosa Ríos, I. (2021). Strength training for throwing velocity enhancement in overhead throw: A systematic review and meta-analysis. *Int. J. Sports Sci. Coach.*, *16*(5), 1223-1235. https://doi.org/10.1177/17479541211002977

Matos, S., Silva, B., Clemente, F. M., & Pereira, J. (2021). Running-related injuries in Portuguese trail runners: a retrospective cohort study. *J. Sports Med. Phys. Fitness*, *61*(3), 420-427. https://doi.org/10.23736/s0022-4707.20.11304-5

McKay, A. K. A., Stellingwerff, T., Smith, E. S., Martin, D. T., Mujika, I., Goosey-Tolfrey, V. L., Sheppard, J., & Burke, L. M. (2022). Defining training and performance caliber: A participant classification framework. *Int. J. Sports Physiol. Perform.*, *17*(2), 317-331. https://doi.org/10.1123/ijspp.2021-0451

Oggero, G., Puli, L., Smith, E. M., & Khasnabis, C. (2021). Participation and Achievement in the Summer Paralympic Games: The Influence of Income, Sex, and Assistive Technology. *Sustainability*, *13*(21), 11758. https://doi.org/10.3390/su132111758

Rodríguez Macías, M., Giménez Fuentes-Guerra, F. J., & Abad Robles, M. T. (2022). The Sport Training Process of Para-Athletes: A Systematic Review. *Int. J. Environ. Res. Public Health*, *19*(12), 7242. https://doi.org/10.3390/ijerph19127242

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The Importance of Muscular Strength in Athletic Performance. *Sports Med.*, *46*(10), 1419-1449. https://doi.org/10.1007/s40279-016-0486-0

Terzis, G., Stratakos, G., Manta, P., & Georgiadis, G. (2008). Throwing performance after resistance training and detraining. *J. Strength Cond. Res.*, *22*(4), 1198-1204. https://doi.org/10.1519/JSC.0b013e31816d5c97

Zaras, N. D., Stasinaki, A. N., Methenitis, S. K., Krase, A. A., Karampatsos, G. P., Georgiadis, G. V., Spengos, K. M., & Terzis, G. D. (2016). Rate of force development, muscle architecture,

and performance in young competitive track and field throwers. *J. Strength Cond. Res.*, *30*(1), 81-92. https://doi.org/10.1519/jsc.0000000000001048

Authors' and translators' details:

Exal Garcia-Carrillo	exal.garcia@gmail.com	Author
Bruno Silva	silvabruno@esdl.ipvc.pt	Author
Nikolaos Zaras	nzaras@phyed.duth.gr	Author
Rodrigo Ramirez-Campillo	ramirezcampillo@gmail.com	Author