



# Article How Does the Jumping Performance Differs between Acrobatic and Rhythmic Gymnasts?

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Abstract: An increased jumping performance is key for gymnastics competition routines. Rhythmic gymnasts (RGs) use the jump as one of the main body elements. In Acrobatic Gymnastics (ACRO), top gymnasts must coordinate their jumps with the impulse provided by base gymnast(s). It is expected that the gymnasts' discipline and role played impact their jumping skill. This work aims to investigate how the jumping performance differs between ACRO gymnasts and RGs, focusing on the Force–Velocity (F-V) profile mechanical variables. Gymnasts were divided in three groups: ACRO tops (n = 10, 13.89 (3.62) median (interquartile interval) years old), ACRO bases (n = 18, 18.24 (4.41) years old) and RGs (n = 15, 12.00 (3.00) years old). The F-V profile during countermovement jump and its mechanical variables were evaluated using *MyJump2*. A training background survey and anthropometric assessments were conducted. The significance level was set at  $p \le 0.05$ . Group comparisons showed that ACRO bases jump higher than ACRO tops and RGs, present a higher maximal force than RGs and a more balanced F-V profile, while RGs present high force deficits. Coaches can use this data to develop interventions that optimize the training stimulus to different gymnastics disciplines considering the individual characteristics and adaptability of each gymnast.

Keywords: sport specificity; jump; gymnastics; acrobatics; rhythmics

# 1. Introduction

Jumping skill, being an important part of gymnastics performance [1], is also identified as one of the predictors of success in this sports activity [2]. Gymnasts' jumping skill is linked to successful performance and is sometimes considered an overall indicator of gymnastics ability [3]. The specific demands of the sport, in addition to the identification of the variables that can be improved in the training process, are some of the most important factors for an athlete's development [4].

Although it is widely accepted that different sports induce different adaptations according to the specificity of that sport, it is also pointed out that athletes' physical characteristics and their mechanical variables are highly individual [5]. As a result, coaches should consider not only the specificity of the activity, but also the individual athletes' adaptation, providing conditions for gymnasts from all gymnastics disciplines to improve their physical abilities, particularly those selected as performance determinants of these sports activities.

An increased jumping performance is crucial for gymnastics competition routines, since this sport requires explosive strength, which can be expressed through vertical jump assessment [2]. Considering that different sports/disciplines require a unique set of competencies, skills and attributes based on their specific demands to ensure optimal performance [6], gymnasts from different disciplines use this skill for specific purposes. Rhythmic gymnasts (RGs) consider the jump as one of the three main body elements, next to balances and rotations. Gymnasts' jump height must be enough to show the shape of



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**Copyright:** © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). the jump [7], to properly execute the technical elements with the apparatus (rope, hoop, ball, clubs and ribbon), and should not be followed by a heavy landing [8]. In Acrobatic Gymnastics (ACRO), two distinct roles are performed: ACRO tops and ACRO bases [9,10]. While ACRO tops need to master aerial and balance skills, ACRO bases are responsible for supporting, throwing and catching ACRO tops [11]. ACRO pairs/groups perform balance and dynamic elements. To effectively perform dynamic exercises, ACRO tops must coordinate their jumps with the impulse provided by ACRO base(s), so that the amplitude of the flight phase is accomplished, according to the official code of points [9]. In addition, both roles need to execute individual floor elements. As a result, an improved jumping skill is key for these disciplines.

It is described that a proper strength/power profile is required from early age for gymnasts to be able to learn the new target skills [12]. As a result, there is a need to develop general strength capacity in gymnasts across their training career [13] and in all levels of performance [14], as well as to produce more in-depth research on strength to assist the future development of gymnastics [14]. The application of supplementary programs with plyometric [15,16], strength [16,17] and proprioceptive exercises [18] is a valid way to increase gymnasts' jumping performance, even at young ages [19]. The development of running and changing direction skills and Countermovement Jump (CMJ) performance can, in turn, improve the performance of gymnastics skills, increasing flight time [19]. This improvement can also have positive implications for the athlete's long-term development [19].

Regarding the evaluation procedures, the Force–Velocity (F-V) profile, representing the optimal balance between force and velocity qualities [20,21], has been considered a relevant parameter for jumping skill assessment [7,22], as well as to maximize the individual ballistic performance. Due to its ballistic/mechanical characteristics, the CMJ is the exercise generally used to evaluate the power output of the lower limbs, as well as the F-V relationship, allowing to obtain the relationship between force, velocity and power. All studies found with interventions in Rhythmic Gymnastics (RG) used the CMJ as the criterion exercise for the evaluation of jumping performance [15–18]. In ACRO, two studies focused on jumping were found: one used the CMJ to evaluate the influence of the range of motion in the jumping performance of girls practicing the sport twice per week [23,24], and the other focused on the effect of two competition floors upon plantar pressures at the gymnasts' feet during landings from two different falling heights [25].

To the best of our knowledge, one study used *MyJump2* app to measure the jumping performance and its variables in RG through the F-V profile [7], while no studies used this instrument in ACRO. The closest activity to gymnastics using MyJump2 app was ballet [22,26], indicating that this new field method based on several series of loaded vertical jumps provides information on the F-V profile mechanical variables [22], thus personalizing the results to the characteristics of individual athletes or dancers [26]. In RG, other instruments were also used: two studies used a force platform [18], while one also used the Chronojump system [15]. Others used the Optojump System [17] and a piezoelectric platform [16]. A previous study evaluated the jump height through the vertical jump test (VJ) [14], in which the athletes jump as high as possible, marking the highest point reached (using ink on the middle finger) [27]. This instrument seems to be easy to handle and access to coaches, allowing to efficiently monitor gymnasts' jump height during training [13,14]; however, the remaining instruments allow to obtain data regarding the jump mechanical variables, which provides more detailed information for coaches. In ACRO, a portable force platform (Quattro Jump®, Kistler Instrumente AG, Winterthur, Switzerland) [23,24] and flexible reference insoles, namely the Pedar Mobile® system (Novel, Germany) [25], were the instruments used to date to assess gymnasts' jumping performance.

Both disciplines use the CMJ technique in their daily training sessions for distinct purposes. RGs use this technique to execute the jumps difficulty elements, followed by a soft and safe landing. ACRO bases also use this technique to pitch/throw ACRO tops. ACRO tops can take advantage of this impulse to jump, while adding somersaults and twists, and finishing with a safe landing. Accordingly, this work aims to investigate how the jumping performance differs between ACRO and RGs. The focus of this investigation is not only the jump height achieved, but also the relationships established between the F-V profile mechanical variables. It would be expected that the gymnasts' discipline and role played, associated with different training habits, could lead to different jumping skills. We hypothesized that ACRO tops and RGs would be the most identical groups in anthropometric variables, while ACRO bases and ACRO tops, as well as ACRO bases and RGs would present more dissimilarities. In jump variables, we hypothesized that the greater differences would be found between ACRO bases and RG groups.

These data will allow to identify the main characteristics of ACRO and RGs' jumping skill, considering their specific training and role. It will also provide information to coaches about the most important variables for RGs, ACRO tops and ACRO bases' training, as well as the imbalances detected in each gymnastics discipline.

#### 2. Materials and Methods

#### 2.1. Sample Characterization

A total of forty-three female Portuguese ACRO gymnasts (n = 28) and RGs (n = 15) participated in this study. ACRO tops and ACRO bases were divided in different groups, similarly to previous studies, due to the distinct roles performed [10,28]. Therefore, gymnasts were divided into three groups, namely 10 ACRO top gymnasts (13.89 (3.62) median (interquartile interval) years old and 6.00 (6.00) years of training experience), 18 ACRO base gymnasts (18.24 (4.41) years old and 8.00 (3.33) years of training experience) and 15 RGs (12.00 (3.00) years old and 7.00 (3.00) years of training experience). The sample inclusion criteria included gymnasts from base and first division national age groups, practicing ACRO or RG, as well as all the gymnasts who volunteered to participate in the evaluation (including their parents' consent). All subjects and their legal guardians (for gymnasts younger than 18 years old), after being informed of the study's purpose, procedures, benefits and risks, gave their voluntary and informed consent to participate, under the Declaration of Helsinki and the approval of the local research Ethics Committee (CEFADE 02.2022).

## 2.2. Procedures and Instruments

Information regarding the training experience (years) and the weekly training volume (hours) of each gymnast was collected through a brief survey. The following anthropometric measurements were performed: the height of push-off (HPO), height, body mass and Body Mass Index (BMI). HPO is the difference between the right greater trochanter height from the ground (measured at 90° knee angle in a squat position) and the extended lower limb length with maximal foot plantar flexion (greater trochanter to tiptoe distance), while the subject is in supine position [29], measured using a measuring tape (SECA, 201) and a goniometer (BASELINE, 12-1001). This measurement is required to compute the F-V profile [29], and it incorporates the usual jump technique used by gymnasts, i.e., with maximal foot plantar flexion.

Gymnasts performed their usual training warm-up and a brief familiarization with the CMJ. Then, the F-V profile was assessed through an incremental loading protocol applied in previous studies [7,21,22,29–34]. Gymnasts started by performing a maximum CMJ without additional load and then performed three incremental loading conditions (four CMJs total), using a 2 min interval for the unloaded condition and a 4–5 min between attempts using additional load [20,21]. The load increments were defined as 5 kg between each jump, i.e., body weight, 5 kg, 10 kg and 15 kg [7]. Gymnasts were instructed to remain in a standing position with their hands on their hips for attempts without additional load and

used weighted vests for attempts using external load [7]. Also, to reach a squatting position with a knee angle of about 90° (although this angle was individual for each subject) [29] and to jump as high as possible. Gymnasts were allowed to perform each load condition twice, and the four best attempts were used for further analysis.

Data was collected using a smartphone app, MyJump2, in an iPhone 5s (Apple Inc., Cupertino, California), with a camera frame rate of 40 fps, scientifically validated for adults and children [35,36]. This instrument was developed to calculate the jump height from flight time using the high-speed video recording facility on the iPhone 5s [35]. It provides information regarding the magnitude and direction of the F-V imbalance (F-V<sub>imb</sub>) of each gymnast, i.e., the ratio between force and velocity, representing the slope of the linear F–V relationship [20]. It also details the jump mechanical variables, such as the theoretical maximal force at null velocity ( $F_0$ ), the maximal power output ( $P_{max}$ ) and the theoretical maximal velocity of extension of the lower limbs during one extension under zero load ( $V_0$ ) [20].  $F_0$ ,  $V_0$  and  $P_{max}$  of the push-off phase were determined from simple computation measures based on body mass, jump height (from flight time) and HPO, and used to establish a linear F-V relationship for each gymnast [29]. A F-V<sub>imb</sub> value around 0% indicates a perfect balance between force and velocity qualities, whereas a F-V profile value higher or lower than the optimal indicates a profile too oriented toward force or velocity capabilities [32]. There are five different F-V profile categories: <60%—high force deficit, 60–90%—low force deficit, >90–110%—well-balanced, >110–140%—low velocity deficit and >140%—high velocity deficit [32]. This method was validated for CMJ in adults [29], and Samozino's method was also used to monitor young athletes [34].

# 2.3. Statistical Analysis

The statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY, United States. The descriptive data are presented as median (interquartile interval), and the non-normal distribution of the variables was confirmed by a Shapiro–Wilk test. This work includes HPO as a variable of interest, similarly to a previous study [21], since the sample is formed by distinct age groups. Accordingly, a Kruskal–Wallis test was conducted to assess intergroup differences. On the pairwise comparisons (post hoc), the Hedges' g Effect Size (ES) was estimated [37]. The ES magnitude was interpreted using the following scale:  $\geq 0.2$  represents a small ES,  $\geq 0.5$  represents a medium ES and  $\geq 0.8$  represents a large ES. The significance level was set at  $p \leq 0.05$ .

## 3. Results

Table 1 depicts the results from the intergroup comparison ( $p \le 0.05$ ).

**Table 1.** Intergroup comparison: ACRO tops, ACRO bases and RGs variables (median (interquartile interval)).

Variables Median (Interquartile Interval)	ACRO Tops (n = 10)	ACRO Bases (n = 18)	RGs (n = 15)	Differences (p Value)	Hedges' g
Sport experience (years)	6.00 (6.00)	8.00 (3.33)	7.00 (3.00)	NS	0.77, 0.68, -0.07
Training volume (weekly hours)	30.00 (0.00)	30.00 (0.00)	12.00 (3.00)	RGs-Base * RGs-Top *	0.00, -7.48, -6.87
Age (years)	13.89 (3.62)	18.24 (4.41)	12.00 (3.00)	Top-Base * RGs-Base *	3.54, 0.16, -2.5
Body mass (kg)	35.40 (14.50)	61.75 (12.30)	59.10 (23.10)	Top-Base * Top-RGs *	4.85, 1.83, -0.09

Variables Median (Interquartile Interval)	ACRO Tops (n = 10)	ACRO Bases (n = 18)	RGs (n = 15)	Differences (p Value)	Hedges' g
Height (cm)	145.00 (18.00)	167.00 (6.00)	151.00 (15.00)	Top-Base * RGs-Base *	5.6, 1.16, -1.77
BMI (kg/m <sup>2</sup> )	16.71 (2.21)	21.96 (3.65)	18.40 (2.60)	Top-Base * RGs-Base *	3.21, 1.02, -1.77
HPO (cm)	33.00 (7.13)	37.00 (3.38)	36.40 (6.00)	Top-Base **	1.4, 0.82, -0.16
CMJ height (cm)	29.64 (3.22)	33.80 (8.11)	27.43 (6.57)	Top-Base ** RGs-Base *	1.50, -0.02, -1.38
$F_0$ (N/kg)	31.95 (9.30)	32.25 (7.02)	27.78 (5.77)	RGs-Base **	0.65, -0.52, -1.07
$V_0 (m/s)$	3.79 (1.18)	3.21 (1.30)	3.23 (1.58)	NS	-0.34, -0.16, 0.25
$P_{max}$ (W/kg)	23.10 (3.93)	26.15 (4.75)	23.05 (9.20)	NS	0.07, -0.14, 0.29
F-V <sub>Imbalance</sub> (%)	71.00 (60.50)	69.00 (40.00)	39.60 (43.50)	RGs-Base *	0.56, -0.88, -1.4

Table 1. Cont.

ACRO—Acrobatic Gymnastics, BMI—Body Mass Index, CMJ—Countermovement Jump, F0—maximal theoretical force, F-V—Force–Velocity, HPO—height of push-off, Pmax—power Maximal Output, RGs—Rhythmic Gymnasts, NS—non-statistically significant, and V0—maximal theoretical velocity. \*  $p \le 0.001$ , \*\*  $p \le 0.012$ . Effect size sequence: ACRO tops vs. ACRO bases, ACRO tops vs. RG, ACRO bases vs. RGs.

As seen in Table 1, pairwise comparisons showed that ACRO bases present significantly higher values in six variables compared to ACRO tops, namely age, all the anthropometric variables and CMJ height. ACRO bases also present significantly higher values in seven variables when compared to RGs, such as the weekly training volume, age, height, BMI, CMJ height, F0 and F-V<sub>Imb.</sub> Finally, ACRO tops present higher weekly training volume and reduced body mass values when compared to RGs.

The F-V<sub>imb</sub> interpretation suggests that ACRO Tops and ACRO bases present a low force deficit (60–90%) and RGs present a high force deficit (<60%).

Figure 1 presents a graphical representation of the spread of data in each variable analyzed and of the Hedges' g effect sizes between each group [37].

Figure 1 also shows the direction of the intergroup differences described in the previous paragraphs, namely in the weekly training volume, age, body mass, height, BMI, HPO, CMJ height,  $F_0$  and F-V<sub>imb</sub>.



Figure 1. Cont.



Figure 1. Cont.



**Figure 1.** The Hedges' g for comparisons in each variable are shown in the above Cumming estimation plots. The plots were created using the tool available at https://www.estimationstats.com [38]. The raw data is plotted on the upper axes; each mean difference is plotted on the lower axes as a bootstrap sampling distribution. Mean differences are depicted as dots; 95% confidence intervals are indicated by the ends of the vertical error bars.

## 4. Discussion

This work aimed to investigate how the jumping performance differs between ACRO and RGs, focusing on the F-V profile mechanical variables. As hypothesized, results showed that ACRO tops and RGs are the most identical groups, since only two variables presented significant differences, namely the weekly training volume and body mass. Our second hypothesis was also confirmed: ACRO bases and ACRO tops (six different variables), as well as ACRO bases and RGs (seven different variables) present the most dissimilarities. In jump variables, ACRO bases and RGs were the most distinct groups.

The most interesting aspect of these intergroup differences is where they can be found. ACRO bases are older (large ES = 3.54) and present higher anthropometric measures (large ES: body mass, height, BMI and HPO = 4.85, 5.60, 3.21, 1.40) and CMJ height (large ES = 1.50) than ACRO tops, which is expected according to the specificity of the roles performed. In fact, in ACRO age groups, a maximum of 5–6 years of difference between ACRO bases and tops within the same pair/group is allowed so that the elements are safely executed. For instance, in the 11–16 age group, an ACRO top aged 11 years old can form a pair with a 16-year-old ACRO base. The same happens with the 12–18, 13–19 and

senior (from 14 years old) age groups. ACRO bases and tops within the same age group are in different stages of the maturation process and present anthropometric dissimilarities. Accordingly, the higher anthropometric measures and CMJ height achieved by the ACRO bases are a result of being older and more mature than ACRO tops. It was previously reported that the older gymnasts and male gymnasts have a higher performance level both in jumping height and power than younger and female gymnasts [38], with no suggestions for improving jump height according to the gymnasts ages or sexes. In addition, the power capacity was strongly related to the gymnasts' performance assessed by coaches [39].

Although ACRO tops and ACRO bases perform the same gymnastics discipline, ACRO has a high role specificity when compared to any other gymnastics discipline. In our results, ACRO bases are older, heavier, taller, and with greater BMI, HPO and CMJ height. A previous study also suggests a greater specialization as gymnasts progress in age [10]. Both roles present a low force deficit (60–90%). However, the interquartile range values presented in the F-V profile clearly underline the results variability (also seen in Figure 1). In fact, not only do different sports induce different adaptations, but we must consider that the athletes' physical characteristics, F-V profiles and their mechanical variables are highly individual [5].

On the other hand, ACRO bases are significantly older and train more hours per week compared to RGs, which is an effect of specific training habits of the present sample. They also present higher values in two anthropometric and three jump mechanical variables. In summary, ACRO bases are taller (large ES = 1.77), with a higher BMI (large ES = 1.77) and maximal force (large ES = 1.07), jump higher (large ES = 1.38) and are more balanced (large ES = 1.40) than RGs. Our results showed that RGs present a high force deficit (39.60 (43.50) %), which is in line with previous reports of low levels of strength in this discipline [7,13,40]. In a sample of RGs, 72.3% of the gymnasts presented a force deficit, 11% presented a velocity deficit and 16.6% were balanced [7]. This is evidence of a clear lack of jump-specific training in RG. The same conclusions were made with ballet dancers, which were characterized as velocity-oriented [30], since all presented force deficits [22].

The present findings show that the gymnasts' discipline and role played, associated with different training habits, lead to different jumping skills, translating to different F-V profiles. Something that we can understand from sports experience data and is common to all gymnasts, regardless of gymnastics discipline, is that there is an early initiation in this sport. This earlier specific initiation and the importance of initial years of practice for a long-term sport career in gymnastics has been reported previously [41]. In our results, ACRO tops and ACRO bases present the same weekly training volume since they train together. However, both ACRO gymnasts present a significantly higher weekly training volume than RGs (large ES: ACRO tops vs. RGs = -7.48 and large ES: ACRO bases vs. RGs = -6.87), with no differences in years of training experience.

In addition, body mass is the only variable with significant differences between ACRO tops and RGs (35.40 (14.50) vs. 59.10 (23.10), large ES = 1.83), although these groups present similar age. Although ACRO tops train more than the double of the weekly hours when compared to RGs, they did not present significant differences in jump variables. One possible explanation is that, in dynamic elements, ACRO tops jump with the impulse provided by the ACRO base(s), indicating that they are not required to develop high levels of force. Instead, they are required to be great acrobats. Moreover, neuromuscular activation, segmental coordination, and the application of a proper technique are very important to maximize impulse and, for instance, the jumping performance [42,43]. Still, they are also required to perform individual floor elements in their routines. Although the spring floor used in ACRO helps to perform these elements more efficiently, the learning and execution of current and new skills may be compromised if the jump capacity is not improved. On the contrary, RGs must elevate their center of mass using the strength that they are capable of exerting against the ground to jump as high as possible. In addition, their floor characteristics are different. ACRO is carried out on a spring floor area  $(12 \times 12 \text{ m})$  [44,45], while the official RG floor area is  $13 \times 13 \text{ m}$  (no springs included). RG floor is more stable than ACRO floor because has less deformation and a much lower degree of repulsion compared to the ACRO floor [46]. Because of these differences, the injuries may be specific to each discipline and may also differ from artistic gymnastics [45]. For instance, some studies suggest that flight time is not the most important predictor of Artistic Gymnastics jumping performance because there is a definitive constraint, such as very restricted contact time to develop an impulse. Thus, stiffness, power and reactivity are more relevant than the flight time [3,12]. It is required to examine the ineffective influence of supplemental training on vertical jump height and how other training regimens could influence jump height in dancers and gymnasts. Authors suggest more rigorous and supervised sessions involving plyometrics training [47] and to prescribe individual training programs based on the F-V profile presented by the athlete [7,22,32].

On the other hand, ACRO bases present higher values in anthropometric variables and a better performance in jump variables. The high power in gymnastics is the result of specialized power training complemented with high force production [48], which is possible through the application of supplementary training processes apart from the usual everyday skill or technical training [12]. In fact, ACRO bases perform strength training daily, both using their body weight or additional load. ACRO tops perform strength training mainly using their body weight. In RG, the focus tends to be placed on achieving higher difficulty in the technical elements and passive and active flexibility training, underrating the strength and plyometric training. However, in the long term, performing gymnastic movement skills alone does not let the gymnast obtain the level of strength and power required for the correct execution of gymnastics skills [49].

It is interesting to note that each gymnastics discipline and role may differ, but they also present matching variables. RGs and ACRO tops present similar age, while RGs and ACRO bases present similar body mass and HPO.  $V_0$  is the only jump variable that is similar between ACRO bases and RGs. These three groups have different traits but also present a few similarities. It is described that the fifty different Summer Olympic Games disciplines require a unique set of competencies, skills and attributes based on their specific demands to ensure optimal performance [6]. Previous findings highlight that each acrobatic sport, which is practiced on a different ground surface, develops specific skills required to prepare, execute and enchain the routines [45]. The differences and similarities found throughout our results analysis make us realize that the type of work carried out in a gymnastics discipline can be extremely useful if shared with other gymnastics discipline. We realized that what is stronger in one of the disciplines can be what is weaker in another, and vice versa, and that sharing experiences, habits and knowledge can obviously help to improve some aspects related to the training process.

Since most of the acrobats at national or international levels are in the puberty period [50], the training schedules should be adapted to each gymnast, considering the training intensity, recovery periods, pubertal growth, and particular attention should be attributed to mental preparation [45], as well as age [7]. Our goal was to provide information to coaches regarding the relevance of jump-specific training, as well as general physical preparation and appropriate strength levels for the training process in all gymnastics disciplines.

We must recognize some limitations of the present study. No specific RG or ACRO exercises/skills were included in the evaluation. Thus, it is difficult to understand the transfer of this physical capacity improvement to specific RG and ACRO skills. A second limitation is the reduced sample size in each group. The adequation of the sample size was not conducted, considering that all the gymnasts who volunteered to participate in the evaluation (including their parents' consent) were included. Therefore, we had a limited number of available gymnasts. Regarding the use of *MyJump2*, the major drawback is that videos are recorded at 120 Hz, so there is a chance that the take-off and/or the landing frame is not recorded [35], although we did not find any case where these frames were not recorded. Also, the equation for the calculation of the jump height uses the flight time squared, which means that the measurement error increases with longer flight times [51]. We must acknowledge that the use of a force plate would provide greater insight regarding

jump strategy. Finally, this work used a cross-sectional design. For future research, a longitudinal design would be necessary to assess the actual long-term effects of such disciplines on the studied performance variables.

## 5. Conclusions

This investigation allowed to identify the main characteristics of ACRO and RGs' jumping skills, considering their specific training and role. ACRO bases presented the highest CMJ height and developed higher  $F_0$  than RGs. While both ACRO roles present low force deficits, RGs present high force deficits. It is imperative that gymnastics coaches introduce strength/power conditioning workouts, apart from the skill training [3]. Coaches can use these data to develop interventions that optimize the training stimulus to different gymnastics disciplines considering the individual characteristics and adaptability of each gymnast.

Appropriate planning allows to perform plyometric exercises in the daily training context without taking a considerable amount of time, therefore improving the jumping performance, health, and safety of the gymnasts [3]. The incorporation of 20 min of strength and plyometric additional training showed to be enough to improve the jump height of ballet dancers, using no equipment and easily incorporated in the dance training schedule and the typical dancer's training space [26].

We hope that this will raise the awareness of gymnastics coaches towards strength training benefits to enhance the jumping performance of gymnasts from different gymnastics disciplines.

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