Original Article

# Strength in young rhythmic gymnasts

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**ABSTRACT**

The aim of this study was: 1) verify if the level of strength in young Portuguese gymnasts change according to competition levels and ranking positions; 2) compare the level of strength in finalists' gymnasts of different competition levels; 3) identify the strength tests that discriminate the gymnasts from the different competition levels. The sample consisted of 68 Portuguese young gymnasts (11.7±0.6 years old) of two different competition levels (Base and 1st division). The International Gymnastics Federation recommended tests for strength assessment were applied. For the statistical analysis, Mann-Whitney and Kruskal-Wallis nonparametric tests, and the discriminant function (forward stepwise) were used. The 1st division presented higher results than the Base gymnasts in all strength tests. Regarding to competition levels by ranking groups, we observed that the finalists in Base level showed higher results than the remaining ranking groups in all strength tests. In 1st division level gymnasts, the finalists achieved higher results only in 66.7% of strength tests than the remaining ranking groups. The finalists in 1st division had higher number of years of training practice in RG and training volume than the finalists in Base level. However, the 1st division gymnasts obtained higher results in 66.7% tests but a superior statistical significance in only one strength test. Lastly, the tests "rope skipping" and "partial trunk elevations" were the strength tests that discriminate the gymnasts groups according to the competitive level. **Key words:** RHYTHMIC GYMNASTICS, STRENGTH, PORTUGUESE GYMNASTS, COMPETITION LEVELS.

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## INTRODUCTION

Rhythmic Gymnastics (RG) requires a hard, prolonged and constant physical training during all sport career (Román, del Campo, Solana, & Martín, 2012). For competitive success and identification of RG potential talent, the main performance motor variables are flexibility, strength, coordination, rhythm, balance, agility and endurance (H. Douda, Toubekis, Avloniti, & Tokmakidis, 2008; Laffranchi, 2001).

However, the strength is considered a basic motor capacity that determines the performance efficiency in RG (Dick, 1993). It has a high importance in most of the movements and elements performed by gymnasts (Lebre, 1993). A correct technical execution, with the appropriate range and intensity, is achieved through a high level of development of this motor capacity (Bobo & Sierra, 1998).

The manifestations of strength developed in this sport are the resistance and explosive strength (Jastrjembskaia & Titov, 1999; Lisitskaya, 1995; Weineck, 1999). It takes a high level of explosive strength of lower limbs to execute a jump of RG and explosive strength of upper limbs to execute a big throw of apparatus (Laffranchi, 2001), but it takes a resistance strength to repeat these elements often during 3 to 4 hours of regular training per day without faults (Helen Douda, Avloniti, Kasabalis, & Tokmakidis, 2007).

In general, the studies have evaluated the strength in gymnasts with distant exercises of the RG reality. Most of the authors were limited to analysing the explosive strength through only the vertical jump (Benck et al., 2002; Del Vecchio, Primeira, Silva, Dall'Agnol, & Galliano, 2014; Grigoroiu, Pelin, Netolitzchi, & Pricop, 2015; Kums, Ereline, Gapeyeva, & Pääsuke, 2005; Menezes & Fernandes Filho, 2006; Román et al., 2012) or vertical and horizontal jumps (Dobrijević, Dabović, & Moskovljević, 2014; Stadnik, Ulbricht, Perin, & Ripka, 2010). Di Cagno et al. (2009) analyzed the vertical jump and included three RG specific jumps in their study. Other authors extended the evaluation of strength with tests of resistance and explosive strength (Donti, Bogdanis, Kritikou, Donti, & Theodorakou, 2016; Helen Douda et al., 2007; H. Douda et al., 2008; Gateva, 2011, 2013; Miletić, Katić, & Maleš, 2004; Miletić, Sekulic, & Wolf-Cvitak, 2004; Rutkauskaitė & Skarbalius, 2009, 2011, 2012). However, the studies do not usually use tests with specific movements of RG. Few studies (Batista-Santos, Lebre, & Ávila-Carvalho, 2016; Donti et al., 2016; Gateva, 2011, 2013; Rutkauskaitė & Skarbalius, 2009, 2011, 2012) had at least one test of strength with similar characteristics of the sport specific requirements.

The tests choice should consider the specificity of the sport, to approach the most of the main characteristics (Barker & Armstrong, 2011; McGuigan, 2014). The application of a specific test of the sport is the great advantage of field research, as it enables the collection of motor performance levels of athletes, and allows the acquisition of relevant data to the coaches (Santos & Soares, 2001). Therefore, due to the necessity of a standard assessment of motor performance in RG, the International Federation of Gymnastics (FIG) has created tests (Klentrou et al., 2010) with body movements' patterns and RG elements, to ensure a close result of the context sport.

The aim of this study was to verify if the level of strength in young Portuguese gymnasts changes depending on the competition levels and ranking positions. Furthermore, compare the level of strength in finalists' gymnasts of different competition levels.

## MATERIALS AND METHODS

### *Subjects*

The sample consisted of 68 Portuguese young gymnasts (11.7±0.6 years old) of two different competition levels (Base and 1st division).

In Portugal, the 1st division is the main and higher competitive level for young gymnasts and Base is the second competitive level with lower demands.

In each competition level, the gymnasts were clustered into three groups according to their ranking position in National Championship: 1st group (Finalists) – 1st to 8th place in the ranking; 2nd group (Non-finalists) – 9th to 27th place in the ranking in Base level and 9th to 16th place in the ranking in 1st division level; 3rd group (Unclassified) – gymnasts not classified for the National Championship in the qualifying competitions.

### *Ethical Considerations*

The study protocol was approved by the Ethics Committee of the Faculty of Sport, University of Porto, Portugal. The requests were sent to the Scientific Committee of the Portuguese Gymnastics Federation, which after being informed about the study, its scientific value and multiple benefits, approved it, allowing the testing to be conducted during the training sessions. All testing was performed in accordance with the ethical standards of the Helsinki Declaration.

### Methodology

*Physical Tests*

The International Gymnastics Federation (FIG) recommended tests were used (Klentrou et al., 2010), to assess the levels of resistance and explosive strength using RG specific movements.

The tests were conducted in a training environment following strictly the protocol proposed. A Nikon Photographic Camera and a Samsung Video Camera were used to register the images and videos. After, the tests were analyzed by two international judges with more than 10 years of experience and 10 days later, the judges repeated the evaluation. We observed high values of intra-examiner reliability (Kendall Coefficient of Concordance) and inter-examiner reliability (Intraclass Correlation Coefficient), which confirms a high quality of information.

*Strength measurements*

Six tests were performed. Part of these tests (Table 1) are exercises characterized by the execution of energetic, fast and continuous movements, by performing the maximum number of repetitions in a given time (30 seconds): front power kicks (FPK), back power kicks (BPK), partial trunk elevations (PTE), partial curl-ups (PCU) and rope skipping (SKP). Therefore, it requires a good level of resistance and explosive strength from the gymnasts, once it demands repetitions with maximum power, i.e., a maximum rhythm, keeping the optimal range of motion with short resting periods. We record in video the exercise execution and after the valid repetitions for each gymnast were counted.

In addition, the gymnasts performed the vertical jump (VJT) (Sargent, 1921), according to the vertical jumping technique with countermovement jump, which is the rapid flexion and hip extension, knee and ankle, in a vertical body projection movement (Komi & Bosco, 1978). The jumping technique was explained in detail verbally, repeated and demonstrated as needed. In the jumping time, it was allowed to freely flex the lower limbs and move the upper limbs, to provide the largest possible vertical impulse.

Table 1. Strength tests (Klentrou et al., 2010)

| TEST | Front power kick (FPK) | Back power kick (BPK) | Partial Trunk Elevations (PTE) | Partial Curl-Ups (PCU) | Rope skipping (SKR) | Vertical Jump test (VJT) |
|---|---|---|---|---|---|---|
| PURPOSE | To measure explosive strength and muscular endurance (lower limbs). | To measure explosive strength and muscular endurance (lower limbs). | To measure explosive strength and muscular endurance (back). | To measure explosive strength and muscular endurance (abdomen). | To measure RG specific explosive strength, coordination and muscular endurance (lower limbs). | To measure explosive strength (lower limbs). |
| EQUIPAMENT | Stopwatch | | | Stopwatch and masking tape | Stopwatch | Ink and scale. (21x120cm, 1.6 – 2.0m from the ground). |
| POSITION | Lying on the back with legs straight. | Lying on the stomach with legs straight. | Lying on the stomach with legs straight. | Lying on the back, knees bent at 90º, feet flat on the floor, legs slightly apart, arms straight and parallel to the trunk with palms of hands resting on the floor. The head is in contact with the floor. | Standing with the rope stopped behind the body or with movement in eight. | Standing with dominant shoulder half a foot away from the wall. The middle finger of the dominant hand is covered with ink. After, it touches in the scale fixed to the wall, and marks the first measure (M1), which is the highest point reached with feet flat on the ground. |
| ACTION | Lifting each leg to vertical position and alternating as many times as possible. The hips in retroversion, upper limbs extended and apart, contracted abdomen, spine upright and fully supported on the ground. | Lifting each leg to vertical position and alternating as many times as possible. The hips in retroversion, upper limbs in forward, next to the body or the elbows used as support, contracted abdomen and fully supported on the ground. | Lifting the trunk vertically with maximum speed. The hips in retroversion, contracted abdomen, lower limbs extended and hands on the head. | Initial phase involves "flattening out" the lower back region, followed by a slow "curling up" of the upper spine. Keeping heels in contact with the floor, the hands move forward, without lifting from the floor, towards the heels. Return to the starting position – repeat. | Double jumps with the rope. | Execution of vertical jump according to the vertical jumping technique with countermovement jump, to mark the second measure (M2), that it refers to the highest point reached during the jump, with the same body segment. 3 trials are allowed. |
| MEASUREMENT | Maximum repetitions in 30 seconds. | | | | | The highest distance (cm) from M1 to M2. |

*Additional data (Age and training characteristics)*

Data on their age, years of training practice in RG and training volume were collected by a questionnaire given to the participants.

*Statistical Procedures*

For statistical analysis of the data we used the Statistical Package for Social Sciences (SPSS) - version 23.0. The significance level was set at 0.05. Descriptive statistics were performed using the mean and standard deviation.

Mann-Whitney and Kruskal-Wallis nonparametric tests were used to compare competition levels (Base and 1st division) and the ranking groups (Finalists, non-finalists and unclassified gymnasts), respectively.

The discriminant function (forward stepwise) was used to find the smallest number of strength tests that maximally separate the gymnasts from the two competition levels.

## RESULTS

Table 2 presents the data related to the training characteristics and strength tests of young Portuguese gymnasts.

Table 2. Training characteristics and strength tests of young gymnasts per competition levels

| Variables \ Age category/Levels | | Young gymnasts (x±sd) | | Proof value |
|---|---|---|---|---|
| | | Base (n=38) | 1st division (n=30) | |
| Age (years) | | 11.6±0.6 | 11.8±0.7 | *p=0.311* |
| Years practice (years) | | 3.8*±2.1 | 5.2*±1.7 | ***p=0.009**** |
| Training volume (hours/week) | | 12.2*±6.0 | 18.4*±6.1 | ***p<0.001**** |
| Strength tests | VJT (cm) | 29.6±5.3 | 30.9±3.7 | *p=0.241* |
| | FPK (rep) | 26.1*±4.9 | 28.5*±3.3 | ***p=0.024**** |
| | BPK (rep) | 17.8±8.0 | 20.8±7.9 | *p=0.078* |
| | PTE (rep) | 10.1*±8.7 | 18.9*±3.9 | ***p<0.001**** |
| | PCU (rep) | 13.8*±4.1 | 16.4*±2.4 | ***p=0.003**** |
| | SKR (rep) | 9.4*±7.7 | 23.0*±12.7 | ***p<0.001**** |

*Legend – VJT: vertical jump test; FPK: front power kick; BPK: back power kick; PTE: partial trunk elevations; PCU: partial curl-ups; SKR: rope skipping.*

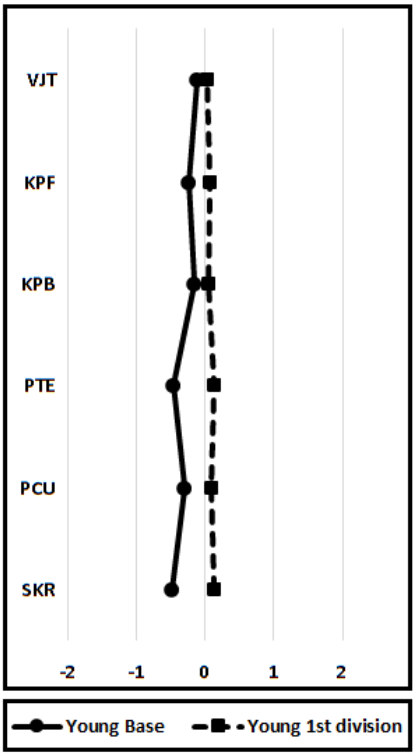
We observed statistical significant differences in years of training practice in RG (p=0.009), in which the 1st division was more experienced with more time sport practice.

Furthermore, the 1st division presented higher results than the same age category in the Base level in all variables analyzed, although significant differences were verified in 67% of the tests: FPK (p=0.024); PTE (p<0.001); PCU (p=0.003) and SKR (p<0.001).

The high standard deviation values in both competitive levels (Table 2) in several physical tests show a high interindividual heterogeneity within each group analyzed.

Figure 1 shows the strength profiles by competitive levels on young category. As expected, we verified a clear advantage of 1st division in all strength tests. Base group obtained values below average in all tests performed. Furthermore, 1st division showed a higher stability in the results.




*Legend – VJT: vertical jump test; FPK: front power kick; BPK: back power kick; PTE: partial trunk elevations; PCU: partial curl-ups; SKR: rope skipping.*

Figure 1. Strength profiles by competitive levels on young category

We can see in Table 3 the training characteristics and strength tests of young gymnasts per competition levels separated by ranking groups in National Championship: Finalists – 1st to 8th place in the ranking; Non-finalists – 9th to 27th place in the Base level ranking and 9th to 16th place in 1st division level ranking; Unclassified – gymnasts not classified for the National Championship in the qualifying competitions.

In Base level, we verified that, in spite of not having statistical significance, the finalists' gymnasts were older, with more years of practice and more training volume than non-finalists and unclassified gymnasts. The best gymnasts in base competition level also presented higher results than the remaining ranking groups in all strength tests. However, significant differences were found only in finalists versus unclassified gymnasts in SKR ($p=0.003$) and finalists versus non-finalists in PTE ($p=0.025$).

On the other hand, the unclassified showed higher results in FPK, PTE and PCU tests than non-finalists gymnasts. The low values presented by non-finalists reflect the high range achieved by this ranking group in the referred strength tests.

In 1st division, we observed significant differences in finalists versus unclassified gymnasts in BPK ($p=0.028$), in unclassified versus finalists and non-finalists in PTE and SKR ($p\leq0.05$). As expected, the unclassified gymnasts showed lower results than the remaining groups, except in VJT test, in which this group presented higher values than non-finalists gymnasts.

Table 3. Training characteristics and strength tests of young gymnasts per competition levels separated by ranking groups

| Variables \ Age category/ Levels | | Base level (x±sd) | | | 1st division level (x±sd) | | |
|---|---|---|---|---|---|---|---|
| | | Finalists (n=8) | Non-finalists (n=19) | Unclassified (n=11) | Finalists (n=8) | Non-finalists (n=7) | Unclassified (n=12) |
| Age (years) | | 11.8±0.6 | 11.6±0.6 | 11.5±0.5 | 11.7±0.6 | 11.7±0.8 | 12.1±0.5 |
| Years of practice (years) | | 4.6±2.3 | 3.7±2.1 | 3.6±2.2 | 5.6±2.3 | 4.4±1.3 | 5.2±1.6 |
| Training volume (h/week) | | 14.8±6.3 | 12.1±5.7 | 10.5±6.2 | 21.3±7.2 | 16.6±4.3 | 18.8±6.0 |
| Strength tests | VJT (cm) | 32.6±4.5 | 29.6±5.4 | 27.2±4.7 | 32.4±4.2 | 30.1±4.2 | 30.5±3.7 |
| | FPK (rep) | 29.4*±3.3 | 24.7±5.9 | 26.0±2.5 | 29.4±3.7 | 29.3±3.6 | 26.8±2.4 |
| | BPK (rep) | 21.1±3.1 | 18.1±7.5 | 15.1±10.6 | 25.6*±5.3 | 20.1±6.9 | 16.9*±8.6 |
| | PTE (rep) | 17.5*±5.5 | 8.1*±8.6 | 8.2±8.4 | 20.5*±3.0 | 21.3*±2.7 | 16.1*±3.8 |
| | PCU (rep) | 14.5±2.6 | 13.2±5.4 | 14.4±2.1 | 16.9±2.5 | 17.3±2.8 | 15.8±2.2 |
| | SKR (rep) | 15.8*±8.8 | 9.6±6.9 | 4.5*±4.7 | 29.8*±5.9 | 28.9*±14.5 | 13.1*±10.0 |

*Legend – VJT: vertical jump test; FPK: front power kick; BPK: back power kick; PTE: partial trunk elevations; PCU: partial curl-ups; SKR: rope skipping. p≤0.05: significant differences.*

The finalists' gymnasts showed higher results in 66.7% of strength tests (VJT, FPK, BPK and SKR), although this group had more years of practice and more training volume than the other ranking groups. The non-finalists achieved higher values in 33.3% of the tests (PTE and PCU).

When we compare the finalists' gymnasts (Base versus 1st division), we observed that the 1st division achieved higher results in 66.7% of the tests (BPK, PTE, PCU and SKR) and a similar result in FPK. The Base group presented higher result in VJT than 1st division, although without statistical significance. Significant differences were found only in SKR ($p<0.001$), in which the 1st division achieved almost twice the number of repetitions of Base.

According to the analysis of the discriminant function, SKR (∧ de Wilks = 0.699, F = 29.516, $p<0.001$) and PTE (∧ de Wilks = 0.616, F = 20.230, $p<0.001$) were considered the strength tests that maximally separate the groups of gymnasts.

Table 4 shows that the overall percentage of the gymnasts' reclassification in their original groups was higher at the Base level (76.3%) than in 1st division level (73.3%).

Table 4. Classification of different competition levels (Base and 1st division)

| Classification Results* | | | | | |
|---|---|---|---|---|---|
| | | Competition Level | Predicted Group Membership | | Total |
| | | | Base | 1st division | |
| Cross-validated | Count (%) | Base | 29 (76.3%) | 9 (23.7%) | 38 (100%) |
| | | 1st division | 8 (26.7%) | 22 (73.3%) | 30 (100%) |

** 75% of cases grouped with cross-validation correctly classified.*

We observed errors of classification in young category: 23.7% “false Base level” and 26.7% “false 1st division level”.

## DISCUSSION

The 1st division in Portugal is the main and higher competitive level for young gymnasts and Base is the second competitive level with lower demands. Therefore, according to analysis of training volume we observed a high difference in the number of hours of training per week between Base (12.2±6.0 hours/week) and 1st division (18.4±6.1 hours/week). The higher competitive level and the more demanding body and apparatus technical elements promote this higher training volume. The finalists’ gymnasts in 1st division had a training volume of 21.3±7.2 hours/week. This group is composed by top national gymnasts in the young category. As in this age category there is no selection of gymnasts to integrate the Elite level in Portugal, the best young gymnasts are in the 1st division, especially the finalists’ gymnasts. Thus, the higher the competition level, the higher the training volume.

International records suggest more than 30 hours of training per week in RG for senior gymnasts (16 years old or older) (Georgopoulos et al., 2012). Ávila-Carvalho, Klentroub, Palomero, and Lebre (2013) observed a training volume between 39.5±7.0 and 41.4±5.9 hours/week in senior elite gymnasts. In junior gymnasts (13 to 15 years old), Batista-Santos, Lemos, Lebre, and Ávila-Carvalho (2015) found a training volume of 25.0h±0 hours/week in elite national gymnasts.

In young gymnasts the lower training volume in comparison to junior and senior gymnasts was expected. In the Rutkauskaitė and Skarbalius (2009) study with 25 rhythmic young gymnasts (11.0 ± 0.82 years old) from the National and Kaunas city teams (Lithuania), the training volume varied from 8.3±2.2 to 14.8±3.2 hours/week. In other three studies (Boligon, Deprá, & Rinaldi, 2015; Donti et al., 2016; Kritikou, Donti, Bogdanis, Donti, & Theodorakou, 2017) the young gymnasts had a training volume of about 24 hours/week.

1st division gymnasts also presented higher number of RG years of practice than Base gymnasts. Furthermore, the best gymnasts in both competition levels (finalists’ gymnasts) showed higher number of years of experience in this sport than the other ranking groups. This higher practice time in RG seems to be an advantage in the gymnasts' performance, probably because it provides some safety and experience in the competitions.

Therefore, as expected, the 1st division gymnasts presented better results than the Base gymnasts in all strength tests performed. These results can be justified probably by higher training volume, more years of practice in RG and possible genetic factors (Hume, Hopkins, Robinson, Robinson, & Hollings, 1993) of the 1st division gymnasts.

The strength profile showed a higher stability in the results of 1st division. The Base gymnasts had a less linear profile and this group obtained values below average in all tests, which demonstrated a clear disadvantage in the strength tests compared to the 1st division.

The strength is one of the main physical capacities that have been identified as contributing factors to performance in RG (Di Cagno et al., 2009; H. Douda et al., 2008; Rutkauskaitė & Skarbalius, 2009, 2011). However, there are few studies about the physical capacities in RG in which specific problems as power and strength are reviewed (Gateva, 2013).

Several authors emphasize the importance of the specificity of the tests performed in the studies with athletes (Barker & Armstrong, 2011; Lebre, 1993; McGuigan, 2014). According to McGuigan (2014), it is also important to critically examine which tests are used and do not choose tests solely because they have been used or because the equipment and expertise are available.

Thus, Gateva (2015) explains that some adequate fitness tests to assess the cardiovascular and specific endurance in RG had to be created in her study: submaximal treadmill test (2 minutes) and specific modified gymnastics routine (2 minutes). Some other sports also have lack of specific assessment as a study in climbing (Michailov et al., 2014).

The strength tests recommended by FIG (Klentrou et al., 2010) and used in our study are easily reproducible in the training environment. Therefore, although it has some limitations, the FIG testing battery is the simplest and quickest way for the coach to control and estimate the progress of the gymnasts, based on their rather easy application in field conditions, the possibility of use in different age groups, the measurement of multiple components with few and simple equipment, without the need to use sophisticated equipment to determine the level of strength condition. Furthermore, the other positive aspect is the achievement of exercises widely used in training sessions and competition routines that provides results close to the reality of RG.

The strength tests used in this study measure the main and most important muscle groups in rhythmic gymnasts' body. Appropriate levels of flexibility and strength are a precondition for proper performance of all basic body elements in RG (Miletić, Katić, et al., 2004). Lower limb explosive strength is a key ability in elements in the body group jumps/leaps (Gateva, 2013). Back and abdominal muscle control are the basis for a successful technical performance in elements of other body groups: rotations and balances (Gateva, 2013).

Thus, a proper physical preparation level is an essential prerequisite for an excellent technical performance (Gateva, 2013). On the other hand, a limited physical preparation level is one of the major problems appearing into the RG practice. According to Monem, Sands, Salmela, P., and Gateva (2011) this is often a result of the coaches' negligence due to their focusing mainly on the technical preparation.

The gymnasts of our study are starting their sports career in RG (11.7±0.6 years old). Therefore, a systematic well-planned training can produce an improvement in the strength levels (Laffranchi, 2001) of these gymnasts.

The gymnasts in both competition levels demonstrated familiarity with most of the exercises evaluated, as these are daily used in the training sessions in order to develop mainly capabilities as flexibility and strength. The main peculiarities observed in the accomplishment of each physical test will be presented below:

In Front Power Kick (FPK) some gymnasts showed lack of coordination in the proposed motion. A LL performs the action of *battement* while the other remains supported on the ground. The second LL only starts the action when the first LL returns to the starting position. The most common mistake among the gymnasts was the elevation of the second LL during the time of the return of the first LL, performing a movement of "*scissors*" with the LL. This error was probably verified because, in general, the *battement* exercises with LL forward are executed with a higher number of repetitions with each LL.

In Back power kicks (BPK) the main difficulties observed were: elevation of LL until 90º and/or maintenance of hip position during the execution of the movement. Some gymnasts needed to raise the hip from the ground

to achieve the desired range of LL (90º), which was not allowed. Thus, each time the gymnast did not reach the correct form of the evaluated exercise, repetition was considered invalid. We also verified gymnasts who achieved the required range only with the dominant lower limb.

In Partial Trunk Elevations (PTE) some gymnasts presented difficulty to correctly perform the desired movement probably because they had a limited degree of flexibility in the spine joints and therefore these gymnasts did not show facility to raise the trunk to the vertical. However, other gymnasts with extreme flexibility did not also achieve excellent results in this test due to low capacity explosive strength and muscular endurance in the spinal region.

The partial curl-up (PCU) is a less familiar exercise between the gymnasts, as it has some rules and details (such as the arms/hands movement in the exercise execution) rarely used in the training practice. However, it is true that the gymnasts perform daily various types of abdominal exercises and so this is a muscular area quite worked.

All test details had been previously explained and the gymnasts made at least one repetition of the exercise, in order to verify the correct execution. However, many gymnasts had repetitions cancelled because they did not perform the proposed movement correctly.

In skipping with the rope (SKR), several gymnasts had difficulties in the correct execution of the skippings and the lack of technical apparatus was the main cause of the low results in this test. In the proposed time (30") many gymnasts made more attempts than double skips with rope. Some gymnasts did not fail to perform a single repetition. In addition, there were gymnasts with better technical apparatus level that presented poor results because they failed in one or two skippings by inattention.

In the vertical jump test (VJT), the jumping technique was explained in detail verbally, repeated and demonstrated as needed. No gymnast showed difficulty in the execution of this test. However, the height of the jump can be affected by the effective use of arms and how the gymnast flexes her knees before jumping (Komi & Bosco, 1978). In our study, the 1st division gymnasts showed higher results in the VJT than Base gymnasts, although without statistical significance. The similar results were verified by Benck et al. (2002), where the elite gymnasts were more explosive jumpers than the non-elite gymnasts indicating that jumping capacities are crucial for gymnastics. These authors also compared the vertical jump (squat jump, countermovement jump and drop jump) in different sports: swimming, tennis, team handball and gymnastics. The gymnasts had the most explosive strength performance as expressed by higher squat and countermovement jumps and better drop jump ratios than the other sports.

Among all strength tests performed by gymnasts in our study, SKR and PTE were considered the most discriminatory tests in the different competition levels (Base and 1st division) on young category. SKR test has a high technical component by the use of the rope; however, in these competition levels we consider that this basic technique should already be consolidated. PTE is a complex test due, especially, to the high strength and flexibility levels required in spine.

In these two tests the 1st division gymnasts presented the expected superiority. However, we observed errors of classification in young category: 23.7% “false Base level” and 26.7% “false 1st division level”, i.e., 23.7% of Base gymnasts had strength characteristics closer to the 1st division gymnasts, while 26.7% of 1st division gymnasts presented insufficient results and values closer to the Base level gymnasts. Therefore, these

results showed that there were gymnasts with strength characteristics closer to the opposite competitive level.

We could say that the other strength tests used do not discriminate the gymnasts and therefore, we can conclude that these tests are inappropriate to compare groups of gymnasts. However, we believe that these results were strongly influenced by the high interindividual heterogeneity within each group analyzed, according to standard deviation values presented in all strength tests performed.

These results were found probably because it was the coaches' decision to register the young gymnasts to compete in the Base or 1st division level. There are no criteria or rules to start or remain at a determined competition level (Base or 1st division), or to guide the coaches' decision. So, gymnasts with high capacities can compete at the lowest level (Base) and gymnasts with limited body and apparatus technical level can to compete in 1st division, independently of the quality or the ranking of their performance. This lack of pre-defined rules induces the gymnasts to the absence of a structural pattern of characteristics in each competition level.

We observed that finalists' gymnasts in Base and 1st division level presented significant differences only in SKR test. Although the 1st division has achieved higher results in 66.7% of the tests, the superiority expected was not shown.

On the other hand, the gymnasts not classified for the National Championship in both groups did not present the lower results, as expected. In the Base level, unclassified gymnasts showed higher values than the non-finalists in 50% of the strength tests, while in the 1st division, unclassified gymnasts had the higher results in the VJT test comparing with all participant gymnasts in 1st division National Championship (finalists and non-finalists).

The success of gymnasts in qualifying to competitions is not limited to strength characteristics. Therefore, we know that the strength assessment cannot be considered as a single criterion for the definition of the competitive level of gymnasts, considering that there are several other physical, technical, tactical and / or psychological factors that directly influence the coach's decision to include a gymnast at Base or 1st division level.

However, these results can promote a reflection on the criteria defined for the participation of young gymnasts in the different levels of competition in Portugal.

## CONCLUSIONS

The gymnasts with higher sport performance level (1st division) presented better results than the Base gymnasts in all strength tests. Furthermore, the 1st division group had a higher number of years of training practice in RG and of training volume than the Base gymnasts.

When the two groups (1st division and Base) were divided by ranking positions, we verified that the finalists in Base level presented higher results than the remaining ranking groups in all strength tests. On the other hand, the non-finalists showed better results than unclassified gymnasts in Base level in 50% of the strength tests.

In 1st division level, the finalists achieved higher results only in 66.7% of the strength tests than the remaining ranking groups. The non-finalists reached better results than unclassified gymnasts in 1st division level in 83.3% of the strength tests.

The finalists in 1st division had a higher number of years of training practice in RG and training volume than the finalists in Base level. Regarding to the strength tests, the finalists in 1st division obtained higher results than the finalists in Base level in 66.7% tests ("back power kick", "partial trunk elevations", "partial curl-ups" and "rope skipping"), similar result in "front power kick" and the finalists in Base presented a higher result in "vertical jump test" than 1st division. However, the superiority statistically significant of finalists in 1st division was verified only in one strength test ("rope skipping"), which the 1st division achieved almost twice the number of repetitions of Base.

Lastly, the discriminant function showed that "rope skipping" and "partial trunk elevations" were considered the strength tests that maximally separate the groups of gymnasts according to the competitive level.

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