DOI: 10.4025/jphyseduc.v35i1.3511

Original Article

THE EFFECT OF 12 WEEKS OF BALLET CLASSES ON THE POWER OF AMATEUR DANCERS

O EFEITO DE 12 SEMANAS DE AULAS DE BALLET SOBRE A POTÊNCIA DE BAILARINAS AMADORAS

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RESUMO
Os grandes saltos são passos que exigem potência muscular e coordenação motora. Visto que há uma escassez na literatura sobre o aprendizado e treinamento destes passos, o objetivo deste estudo foi verificar o efeito de doze semanas de aulas de *ballet* clássico com o exercício *de grand allegro* sobre a potência de membros inferiores em bailarinas amadoras. Participaram sete bailarinas, com 11,33±1,02 anos de idade, que cursavam o *Grade 3* da *Royal Academy of Dance*. Foram realizados cálculos de Pico de Velocidade de Crescimento, testes de salto vertical e avaliação técnica do *grand allegro* em quatro momentos durante doze semanas. Os planos de aula, Percepção Subjetiva de Esforço e Qualidade Total de Recuperação de cada aula foram analisadas. Os principais resultados apontam bailarinas pré-púberes, cuja potência muscular e técnica do exercício de *grand allegro* apresentaram melhora (p<0,05). A carga semanal e quantidade de saltos e de exercícios executados variaram durante o período, enquanto que a Qualidade Total de Recuperação se mostrou estável. Os dados obtidos apontam para as variações da carga de trabalho nas aulas de *ballet* somadas à fase sensível do desenvolvimento e coordenação motora como os responsáveis pela evolução na potência muscular e na qualidade técnica.
Palavras-chave: Ballet; Força muscular; Performance esportiva.

ABSTRACT
The big jumps are steps that require muscular power and motor coordination. Since there is a lack in the literature on the learning and training of these steps, this study aimed to verify the effect of 12 weeks of classical ballet classes with the *grand allegro* exercise on lower limb power in amateur dancers. Seven dancers, aged 11.33±1.02 years, who were studying the Royal Academy of Dance Grade 3, participated. Peak Height Velocity calculations, vertical jump tests, and technical evaluation of the *grand allegro* exercise were performed at four moments over the 12-week study period. Lesson plans, the Rating of Perceived Exertion, and the Total Quality of Recovery for each class were analyzed. The main results indicate prepubertal dancers, whose lower limb muscular power and *grand allegro* exercise technique improved (p<0.05). Weekly load and the number of jumps and exercises performed varied during the period, while Total Quality of Recovery remained stable. The obtained data point to variations in the workload during ballet classes, combined with the sensitive period of development and motor coordination, as responsible for the improvement in muscular power and technical quality.
Keywords: Ballet; Muscle strength; Athletic performance.

Introduction

Classical ballet has numerous steps that require muscle power of the lower limbs, such as the *grand allegro*, which is often performed in classes and choreographies and "requires the complete coordinated use of the feet, legs and arms to generate the greatest strength necessary for a great elevation"[1:79]. In this context, power and motor coordination are highlighted as the main bio-motor skills required for its performance and for good general performance in the dance[2]. Therefore, for dancers to be able to perform this step satisfactorily, an adequate preparation is essential, which, in turn, consists of three systems: competition, training, and complementary factors[3]. In this scenario, we note a proximity between the systems when preparing an athlete for competitions in sports and ballet, with presentations and exams composing the competition system, and classes, the training system.

Regarding classical ballet, when analyzing metabolic (aerobic and anaerobic) and muscle strength indicators, a difference between the energetic demands of the performances and the stimulus offered in the classes can be identified[4]. This is due to the culture of the ballet training system, which prioritizes almost exclusively the technical component, which is why professional dancers have a physical performance below athletes of corresponding levels in other modalities[5]. Although the performances are characterized as high-intensity interval exercises, ballet classes alone do not seem to offer adequate stimuli for efficient adaptation and performance in professional dancers[6].

However, considering basic categories and training, it is possible to identify the Royal Academy of Dance (RAD) method—created by the renowned institution of the same name—which has a teaching and evaluation methodology for dancers and teachers. Training is divided into levels and each stage holds in its program exercises and steps that must be evaluated with exams, usually once per year. These exams are taken by a registered examiner who scores each block of exercises from zero to 10[7]. When analyzing the levels and requirements of the RAD exams, a gradual evolution can be perceived, especially regarding exercises that require power. Grade 3 is the first level in which jumps with large vertical and horizontal displacements are employed and thus this level was chosen[7,8].

Since some studies[4-6] indicate that ballet classes offer inadequate stimuli for muscle power capacity considering professional dancers, the following question arises: what is the effect of regular ballet classes with *grand allegro* training on the lower limb power of dancers in training? Is there an evolution in performance over time?

Thus, this study aimed to verify the effect of 12 weeks of classical ballet classes with the exercise of *grand allegro* on the lower limb power of amateur dancers.

Methodology

Sample

The sample is non-probabilistic and intentional[9], and was composed of seven dancers (11.33±1.02 years, 41.31±5.50 kg, 151.57±8.24 cm) who attended Grade 3 of the RAD methodology in a dance school of the inland São Paulo. All students with weekly training in classical technique of at least 120 minutes at the indicated school were included. Dancers who did not perform all the tests, had 25% of absences from regular classes during the research, and/or practiced another type of dance or physical conditioning were excluded. All participants were preparing to take the Grade 3 RAD exam, which is scheduled to take place 20 weeks after the start of the study. The research lasted 12 weeks and was approved by the Research Ethics Committee by Plataforma Brasil, under protocol number CAAE: 57512622.7.0000.5404. Before the collections, all the procedures and objectives of the research were explained to the dancers and their guardians, who agreed and signed an informed consent form.

Experimental design

This is a longitudinal descriptive study. Thus, there was no intervention in the variables, but an observation over time and interpretation after their occurrence[10].

The study was divided into four moments. The dancers were attending their regular ballet classes and preparing for the RAD exam. Before the dancers started learning the *grand allegro* exercise, Moment I (week zero) was established, in which the participants underwent anthropometric evaluation and the first muscle power tests.

From this collection, Moments II, III, and IV were established, at weeks four, eight, and 12, respectively. In each Moment, muscle power tests were applied alongside the video recording of the *grand allegro* exercise for technical evaluation. The dancers followed their regular classes without interference from the researchers, and the collection of the Rating of

Perceived Exertion (RPE) and the Total Recovery Quality (TQR) was carried out by the class teacher, who has the Certificate in Ballet Teaching Studies and a teaching degree in Physical Education. This information, as well as the lesson plans, containing the number of exercises and jumps planned and executed, were passed on to the researcher at the end of each class, with the delivery of the teacher's records.

Biological maturation

To evaluate the stage of biological maturation, the information from the anthropometric evaluation was used to calculate the Peak Height Velocity (PHV) following the PHV equation for girls[11,12]:

PHV = −9.376 + 0.0001882 × (LLL × TCH) + 0.0022 (CA × LLL) + 0.005841 × (CA × TCH) − 0.002658 × (CA × TBM) + 0.07693 (TBM/HT), where CA=chronological age; LLL=lower limb length; TCH=trunk-cephalic height; TBM=total body mass; and HT=total height.

Workload

The lesson plans created by the *RAD* registered teacher were further analyzed to quantify the exercises and jumps performed in each class, according to the reported number of jumps per exercise performed and their repetitions. The Total Quality of Recovery (TQR) proposed by Kenttä and Hassmén[13] was applied before each class and the Rating of Perceived Exertion (RPE) proposed by Borg et al.[14] was used after each class. The TQR scores ranges 6–20, with 20 being the maximum recovery and the RPE ranges 0–10, where 10 is the maximum effort. Based on the PSE information provided by the dancers and the duration of the classes in minutes, the daily training load could be calculated with the product of these two variables. Thus, the mean and standard deviation of daily training loads, monotony, and strain were calculated as markers of overtraining[14-16]. Notably, before the beginning of the collections, the RPE and TQR scales were presented to the dancers and used in some classes as a form of familiarization with the material. The calculations of the weekly load were performed according to the days of training and rest of the dancers' routine. Regarding number of jumps performed during classes, the values were calculated according to the count of jumps of the official syllabus or educational exercises multiplied by the number of repetitions performed with the music that the teacher reported in the lesson plan. Jumps made in informal situations, outside the context of the execution of the exercises, were disregarded.

Lower limb power

Lower limbs power was assessed by vertical jump with the Squat Jump (SJ) and Countermovement Jump (CMJ) techniques with the hands on the hips[17,18] and with the aid of the arms (CMJa) since, in ballet, the upper limbs move during the exercises, to improve the height and speed of the jumps[19]. The following variables were analyzed: AT – Air time (ms); H – Height (cm); P – Power (W); and Pr – Relative power (W/kg). The CEFISE® contact mat was used and each participant warmed up for approximately five minutes, with rotation exercises of the main joints of the body, emphasizing the lower limbs, and then three jumping attempts were performed with a rest of 10 seconds between them. The highest jumping height (cm) was considered. There was a three-minute interval between each jumping protocol[18].

Ballet technique

The *grand allegro* exercise of each dancer was recorded for the evaluation of the technical progression. The filming of this exercise was carried out from Moment II onwards, on weeks four, eight, and 12, since, in week zero, the dancers had not yet learned the aforementioned exercise. The filming was recorded the iPhone 8® smartphone camera, with 4K resolution at 60fps and was analyzed according to the evaluation criteria provided by RAD[7]: correct posture and weight placement; co-ordination of the whole body; control; line; spatial awareness; and dynamic values. Each participant had a single chance to perform the exercise to be filmed, so that more attempts could influence learning. Grades were later attributed by the responsible researcher, who holds a teaching degree in Physical Education, in addition to training at the Advanced Foundation level of the RAD methodology, which allows for teaching of classical ballet to young dancers.

Statistical Analysis

After data collection, the information was entered into an Excel database, and then presented in the descriptive scope using measures of centrality and dispersion (mean and standard deviation). In the inferential study, the design used was to consider repeated measures in the same individual at four consecutive moments (Moments I, II, III, and IV), in a single sample group. For this type of design, given the dependence of the responses at the Moments, the multivariate analysis of variance technique (MANOVA) was used, which in this case requires the multi-normality of the data, which was verified by the HENZE-ZIRKLER test, and the procedure was complemented with the multivariate test of comparisons constructed with the simultaneous Bonferroni confidence intervals to ensure the 5% joint significance for all comparison pairs[20].

Results

Based on the data collected, the results will be presented: i) regarding the characterization of the profile of the dancers; ii) regarding the variables related to workload, recovery, and number of jumps and exercises in ballet classes (Table 1 and Graphs 1 and 2); iii) regarding the variables of muscle power (Table 2); iv) regarding the variables of the technical evaluation (Table 3); and v) regarding the statistical analysis.

Profile of the dancers

Regarding sample characterization, participants' age was 11.33±1.02 years, body mass was 41.31±5.50 kg, height was 151.57±8.24 cm, trunk-cephalic height and lower limb length were 75.00±2.08 and 76.57±7.85 cm, respectively. In addition, they had 4.93±1.57 years of practice of the modality. Regarding biological maturation, no participant had yet reached PHV, which ranged from −2.88±0.59 to −2.77±0.63 at the beginning and at the end of the analyzed period ($p>0.05$).

Workload

During the research, the participants had two 60-minutes long classes per week (on Tuesdays and Thursdays at the same time), totaling 48 hours of recovery between the first and second classes and 120 hours of break from one week to the next. The analysis of the lesson plans found that the participants did not do variations of muscle power training, only the jumps that were part of the exercises of the RAD program or educational teaching exercises for them. In other words, the main objective of the classes was to teach and improve the exercises and not a specific bio-motor ability. The mean values of TQR, RPE, weekly and daily load, monotony, strain, exercise, and jumps collected are presented in **Table 1**.

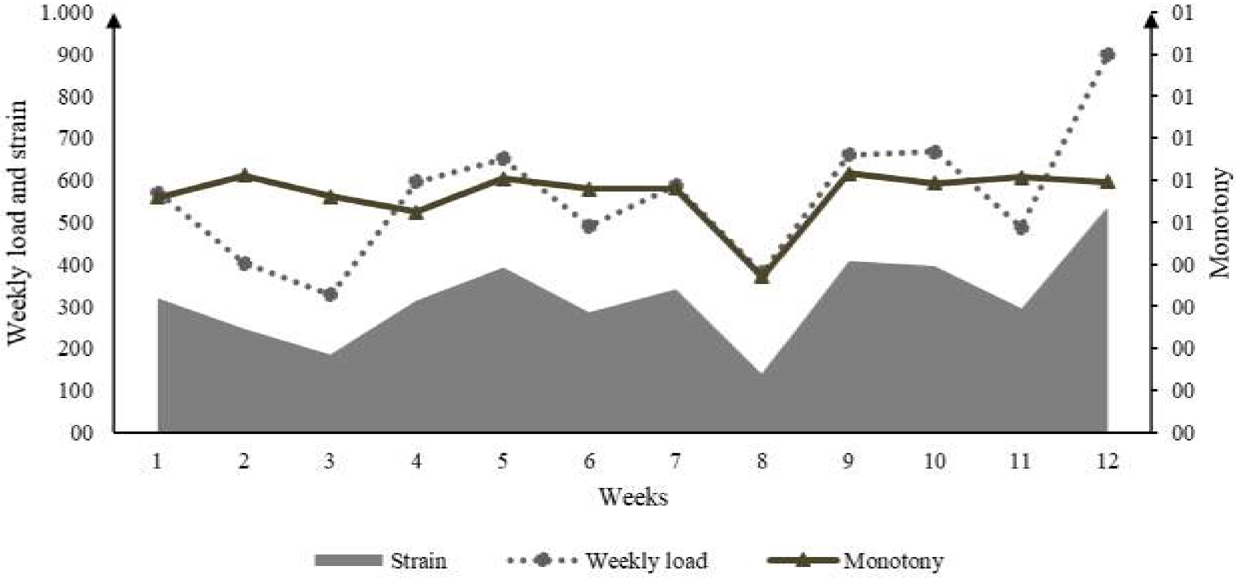
Table 1 – Descriptive measures of the variables related to workload and recovery according to the weeks analyzed.

Week	TQR	RPE	Weekly load (AU)	Daily load (AU)	Monotony (AU.)	*Strain* (AU)	Exercises (n)	Jumps (n)
1	16.3±1.8	4.8±1.7	570.0	78.8±140.7	0.6	319.1	4±1.4	30.0±8.5
2	16.9±1.3	3.4±0.6	402.9	57.6±94.0	0.6	246.5	4.5±0.7	60.5±85.6
3	16.8±1.5	2.8±0.6	327.4	42.1±75.0	0.6	184.0	6±0.0	73.0±32.5
4	17.4±1.1	5.4±1.7	595.7	77.0±146.8	0.5	312.3	3±0.0	82.0±4.2
5	17.1±1.4	5.4±1.3	651.4	93.1±154.0	0.6	393.7	8.5±7.8	245.0±114.6
6	17.9±1.0	4.2±1.1	491.4	67.5±116.5	0.6	284.7	4±1.4	103.5±146.4
7	17.5±1.1	4.8±1.2	587.1	78.8±135.7	0.6	340.8	3±2.8	37.5±53.0
8	17.0±0.9	6.3±1.4	380.0	48.5±131.0	0.4	140.7	4.5±6.4	12.0±17.0
9	17.7±1.1	5.5±0.9	660.0	94.3±153.0	0.6	406.8	9±1.4	67.5±9.2
10	18.4±1.3	5.6±1.7	668.6	95.5±161.1	0.6	396.5	5.5±3.5	0.0±0.0
11	18.2±1.5	4.1±0.9	488.6	69.8±115.1	0.6	296.2	1±0.0	0.0±0.0
12	18.7±1.0	7.5±2.1	900.0	128.6±215.6	0.6	536.6	13±7.1	93.5±17.7

Source: prepared by the authors.

Based on Table 1, Erro! Fonte de referência não encontrada. presents the values referring to the weekly load, strain, on the left axis; with monotony, on the right axis, which followed approximately the same pattern.

Graph 1 – Mean values of the weekly load, monotony, and strain variables, according to the 12 weeks analyzed.

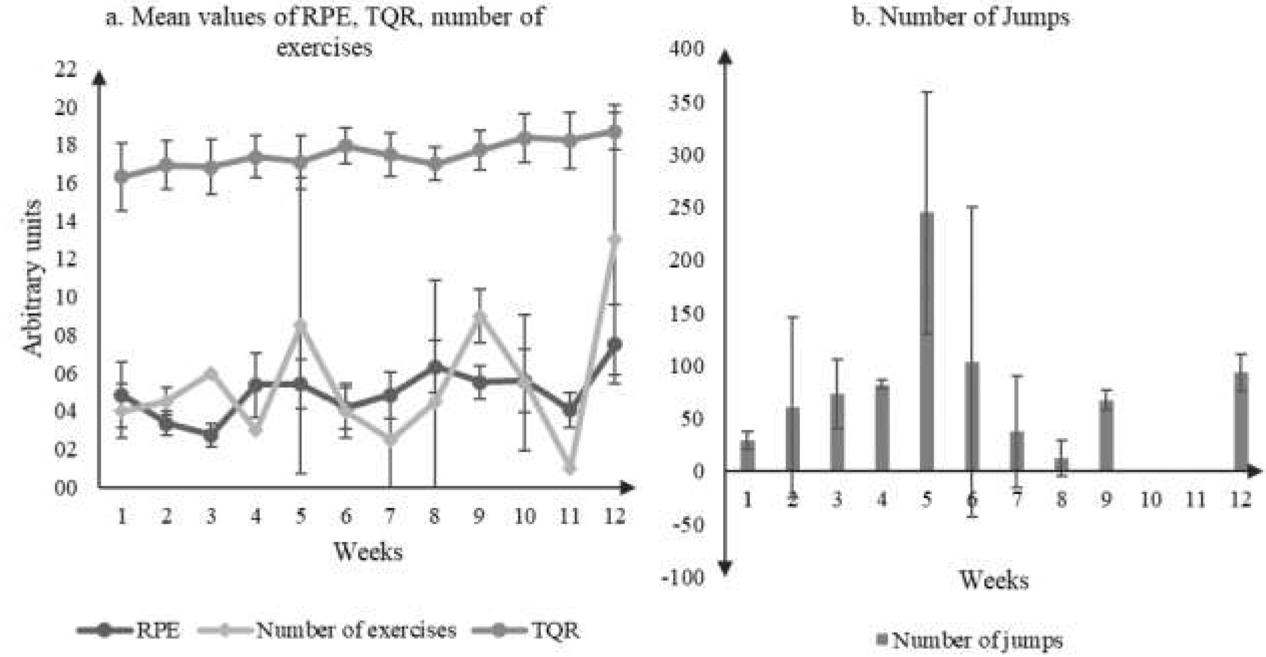


Source: prepared by the authors.

The weekly load ranged from 327.4 in week three to 900.0 in week 12, evolving progressively. Monotony indices greater than 2.0 are predictive of overtraining and an indicator of poor adaptation to training[15]. However, during the study period, the monotony was below 0.6 and the strain value peaked in week twelve, with 536.6. Combining low strain and monotony values and high TQR values, it can be inferred that the load/rest ratio was ideal for the dancers to properly recover from one session to another.

Graph 2 shows the data regarding the mean number of exercises and jumps.

Graph 2 – Mean values of RPE, TQR, number of exercises, and number of jumps, according to the 12 weeks analyzed.



Note: TQR=Total Quality of Recovery; RPE=Rating of Perceived Exertion.
Source: The authors.

The mean TQR remained above 16 in all weeks, whereas the mean RPE ranged from 2.8±0.6 in week three, to 7.5±2.1 in week 12. The mean amount of exercise ranged from 1.0±0.0 in week 11 to 13.0±7.1 in week 12, varying considerably from one week to the next. The RPE varied independently and the TQR remained stable even after a peak in the weekly mean of the number of exercises or jumps performed, not following the behavior of the variables of jumping and exercises practiced.

According to the lesson plans, the choice of activities applied in each training was planned according to the learning pace and degree of importance of the exercises. For example, the two classes taught in week 11 were dedicated to learning and reviewing Dance A, which, alone, is worth up to 20 points[7]. In other classes, all the exercises learned so far were performed, such as class 13, in week seven, with 14 exercises, and class 24, in week 12, with 18 exercises, conducted as a simulated exam. The mean number of jumps per week ranged from zero in weeks 10 and 11 to 245.0±114.6 in week five, due to specific classes to improve jumping exercises and others focused on improving other types of exercise.

Lower limb power

Table 2 shows the mean values for the lower limb muscle power tests.

Table 2 – Descriptive measures of the variables obtained by muscle power tests, according to the weeks analyzed.

Test and Parameter	Moment I	Moment II	Moment III	Moment IV	p-value
SJ – AT	414.14±30.14a	435.00±24.62ab	443.57±24.60b	443.71±30.44b	p<0.05
SJ – H	21.10±3.07a	23.26±2.70ab	24.19±2.76b	24.24±3.42b	p<0.05
SJ – P	1091.55±390.61a	1256.70±360.93b	1300.45±387.50b	1328.04±312.46b	p<0.05
SJ – Pr	25.73±6.41a	29.50±5.25ab	30.64±5.58b	31.25±5.40b	p<0.05
CMJ – AT	426.14±31.91a	429.14±26.44ab	443.57±25.08b	444.14±34.15b	p<0.05
CMJ – H	22.36±3.43a	22.64±2.85ab	24.19±2.79b	24.30±3.76b	p<0.05

Test and Parameter	Moment				p-value
	I	II	III	IV	
CMJ – P	1181.20±443.73a	1213.15±426.89ab	1300.60±385.52bc	1369.93±417.30c	p<0.05
CMJ – Pr	27.69±7.15a	28.90±5.45ab	30.66±5.55b	31.32±6.41b	p<0.05
CMJa – AT	459.43±33.34	466.00±35.24	472.29±25.12	472.57±33.93	p<0.05
CMJa – H	25.99±3.71	26.77±4.12	27.41±2.91	27.50±3.93	p<0.05
CMJa – P	1391.49±428.30a	1469.95±455.79ab	1489.24±351.00ab	1563.16±378.15b	p<0.05
CMJa – Pr	33.16±6.55	34.45±6.64	35.59±4.65	36.10±5.84	p<0.05

Note: SJ=Squat jump; CMJ=Countermovement jump; CMJa=Countermovement jump with the aid of the arms; AT=Air time (ms); H=Height (cm); P=Power (W); Pr=Relative power (W/kg). Two measurements, with at least one equal letter, do not differ from each other (p>0.05) according to the Bonferroni test[20].
Source: prepared by the authors.

After 12 weeks, most of the power measurements showed significant improvement (p<0.05) except for the variables of Countermovement jump with the aid of arms (air time, height, and relative power). Regarding the other variables, most of them showed statistically significant improvement between Moment I and Moment III, with the exception of Power in the Squat jump and Countermovement jump with the aid of arms, with an increase from Moment I to Moment II and Moment IV, respectively. On the other hand, the variable Countermovement jump (Power) improved between Moments I and III and between Moments II and IV.

Thus, after eight weeks of ballet classes and of learning the *grand allegro* (Moment II), it was already possible to observe the positive effects of the training on the variables of Countermovement jump (all variables) and Squat jump (height and relative power). Countermovement jump with the aid of arms (power) was the variable that took the longest to show effects, showing improvement only 12 weeks after the beginning.

Technical Evaluation

Table 3 shows the descriptive measures of the grades of the *grand allegro* exercise, according to the RAD evaluation criterion.

Table 3 – Descriptive measures of the grades of the *grand allegro* exercise according to the RAD's evaluation criterion.

Evaluation criterion	Week				
	0	4	8	12	p-value
Correct posture and weight placement	-	5.1±0.69a	5.3±0.49a	6.9±0.69b	p<0.05
Co-ordination of the whole body	-	5.1±0.69a	6.4±0.79b	8.1±0.69c	p<0.05
Control	-	4.7±0.95a	5.7±1.11b	6.7±0.49c	p<0.05
Line	-	4.9±1.21a	5.4±0.79ab	6.4±0.98b	p<0.05
Spatial awareness	-	5.4±0.79a	6.3±0.95a	8.1±0.90b	p<0.05
Dynamic values	-	4.9±1.07a	6.0±1.15a	7.4±0.98b	p<0.05
Final grade of the exercise	-	5.0±0.75a	5.9±0.75b	7.3±0.59c	p<0.05

Note: Two measurements, with at least one equal letter, do not differ from each other (p>0.05) according to the Bonferroni test[20].
Source: prepared by the authors.

According to the lesson plans, identifying preparatory exercises for the *grand allegro* was possible in five classes up to week four. In the other eight weeks, the *grand allegro* exercise was worked on six classes. In Moment II, the dancers performed only the first sequence of the exercise, with the original music, without the required changes of direction. In addition, the movement of the upper limbs was free, so that the dancers performed what was most comfortable in the performance during the recording, since they had only a single shot at filming. By Moment III, the dancers had already learned the full exercise, but they still showed confusion about the correct positions of the arms, chaining of steps, and use of space. In

Moment IV, the dancers already demonstrated a good command of the exercise, with fewer errors.

The results show that the criteria Co-ordination of the whole body, Control, and Final grade of the exercise had a significant improvement in each of the moments evaluated. The criteria Correct posture and weight placement, Spatial awareness, and Dynamic values only showed improvement between Moment III and Moment IV. The Line criterion, precisely the one that obtained the lowest mean in the last collection, was the only one that improved between Moment II and Moment IV.

Discussion

This study considered the relationships between the classical technique and the muscular power of the lower limbs of the dancers. During the training period, dancers received stimuli with low workload and classes with little or no jumping exercises, but they still showed a significant improvement in most of the power and technique variables. The RPE oscillation, which was different from what was expected regarding the amount of exercises and jumps, probably occurred due to aspects other than those collected in this study. The overtraining indicators showed that the dancers were in favorable conditions for good recovery and adaptation to training.

Regarding power, most variables analyzed showed evolution between weeks zero and eight, with the greatest evolution observed in the period in which the number of jumps performed in class peaked (week five). It seems that the increase in the number of jumps performed in classes focused on the execution of the *grand allegro* (between weeks five and six) explains the improvement observed in muscle power variables.

Martin's sensitive periods[21] show that the young dancers were at a favorable age for the development of coordination, motor learning, and speed and unfavorable for the improvement of strength. Even so, power testing results significantly increased, probably made possible by the evolution in speed and motor coordination. By improving the coordination and efficiency of the neural signals of specific muscles, by learning and repetition processes, it is possible to achieve a progression in performance in a specific action even before significantly improving muscle strength[22]. The Countermovement jump test with the aid of the arms did not show improvement in all aspects evaluated, certainly due to the dancers having few opportunities to perform this type of jump, which may have resulted in a lack of coordination of the movement patterns between the upper and the lower limbs. Thus, danceres did not yet have their neuromuscular system optimized to be able to express their power[23].

Regarding the evaluation of the technique, the evolution trend of each criterion was heterogeneous, not following a pattern. With the evolution of the score of the Co-ordination of the whole body and Control criterion—between week four and eight—the dancers were able to achieve a greater mastery over the movement pattern of the exercise evaluated, muscle activation was optimal and moving efficiently was feasible, which increased the score of the other criteria and, consequently, the overall grade. In conclusion, the training sessions achieved the objective of teaching and improving the execution of the *grand allegro* exercise, even though there were still eight weeks of preparation for the final exam.

Final considerations

This work sought to approach ballet from the perspective of sports preparation, prioritizing investigation from the execution of the steps of *grand allegro* due to the specificity of the gestures and the proximity to the bio-motor capacity power. To understand how the muscle power of the lower limbs evolves, a scenario of learning the *grand allegro* was chosen, as occurred in Grade 3 of the RAD, the first level of the methodology for the leap forward step. There are few studies on amateur practitioners in ballet, especially when compared with other modalities. Therefore, this research aimed to verify the effect of 12 weeks of training of the *grand allegro* exercise during regular ballet classes on the lower limb power and the technical quality of amateur dancers.

Although other factors not studied in this study—such as nutrition and sleep—could interfere with the final outcomes, the main results suggest that the dancers improved both the *grand allegro* technique and the lower limb power after 12 weeks of regular classes. The maturational stage in which the participants found themselves was opportune for the young women to improve their coordination and speed of movements. Motivation for learning and stimulation of cognitive abilities also have the advantage of being stimulated during this period. On the other hand, spatial orientation and strength seem to have greater potential if they develop from the age of 12.

Thus, the ballet classes alone, with the *grand allegro* training and the other jumping exercises proposed by the RAD program were adequate to increase the lower limbs power of the dancers in training.

However, since they all participated in the same classes with the same teacher, one of the limitations of this study is that it does not compare different ways of organizing the preparation for the exams. Another limitation is the sample size. However, the results can be generalized in dancers of this age group who are dedicated to learning and progressing within the grades of ballet.

To continue research on this subject, we suggest using more dancers and with a wider age range, with a study period that covers all the preparation for the exam; evaluating a greater amount of exercises or movements; and combining regular *ballet* classes with physical preparation training to compare whether, with complementary stimuli, the dancers can evolve further.

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Acknowledgments: The authors thank Espaço da Escrita – Pró-Reitoria de Pesquisa – UNICAMP – for the language services provided.

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Received on March 08, 2023.
Reviewed on March 13/2024.
Accepted on March 20, 2024.

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