Ger J Exerc Sport Res 2022 · 52:68–75
<https://doi.org/10.1007/s12662-021-00740-8>
 Received: 21 October 2020
 Accepted: 11 July 2021
 Published online: 11 August 2021
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Evaluation of two different 1-year training programs among prepuberal female children

Introduction

Classical dance (D) and rhythmic gymnastics (R) are two of the most popular disciplines among children and adolescent females (Altmann, Roberts, Scharfbillig, & Jones, 2019). In particular, dance is a discipline strongly linked to social activities and it contributes to maintain adequate levels of physical exercise through movement with group activities and music. On the other hand, rhythmic gymnastics combines technical and artistic parameters, with the aim of reproducing an optimal execution model, both in form and execution (Díaz-Pereira, Cómez-Conde, Escalona, & Olivieri, 2014).

Generally, classical dance training starts in childhood, between 4 and 6 years of age (Steinberg, Tenenbaum, Stern, Zeev, & Siev-Ner, 2019). Most data agree in affirming that dance activity exerts positive effects in terms of motor skills, psychosocial factors and anthropometrical values (Steinberg et al., 2019; Teixeira-Machado, Arida, & de Jesus, 2019; Atkins et al., 2018; Gruodyte et al., 2009). Ballet dance, representing the first choice of sportive discipline selected by female children, requires intensive training starting in childhood to reach the demanded aesthetic standards in elite dancers (Haller et al., 2003). In addition, coordination and balance abilities are common skills required during adolescence. Several reports considered the

impact of ballet dance training programs on general motor development (Srhoj, Katić, & Kaliterna, 2006); indeed, Anjos and Ferraro (2018) showed that children who participated in an educational dance program achieved significant gains in balance, fine motor and overall praxis. On the contrary, regarding anthropometrical values, Bowerman, Whatman, Harris, and Bradshaw (2015) found that young professional female ballet dancers show a delayed growth onset. Other authors have observed a prevalence of low bone mineral density and an increased risk of osteoporosis in young elite female ballet dancers (Amorim et al., 2015).

It is important to understand that the regulation of anthropometrical parameters and performance values by dance activity are quite heterogeneous depending on the type of training. Liiv et al. (2013) examined anthropometric variables and aerobic capacity between three groups of dancers: classical ballet dancers, contemporary dancers and dancesport dancers. They concluded that dancers are generally more muscular than their ballet counterparts, while dancesport dancers are taller and heavier, less muscular, with slightly greater adiposity compared to the classical ballet dancers. Ballet dancers had the lowest body fat percentage, weight, and body mass index (BMI) values.

Even considering the above-mentioned studies, to the best of our knowledge, no published data are available about the different effects of distinct

dance training programs on female, prepuberal children in terms of motor skills and at both baseline and after 1 year training. Thus, the scope of this study was to analyse and compare the effects of two different training concepts in terms of anthropometric indices and supervised motor test performance in order to assess the most performant dance method guaranteeing harmonic growth and the development of motor skills. In particular, we aimed to analyse the efficacy of simple classic dance and a combination of it with gymnastics in terms of skill-related variables and anthropometric measures in a sample of children attempting two different typologies of training commonly adopted in dance schools: a classic dance training and an integrated method (with elements deriving from rhythmic gymnastics).

Therefore, two groups of children female dancers were considered; the first group, namely the D group, was trained using typical classical dance training (D group), while the second one, called D&R group, used a mixed training routine, with exercises of classical dance and rhythmic gymnastics. To this aim, anthropometrical parameters and motor skill performance were measured at the beginning of monitoring (T1) and after 1 year of training (T2).

Table 1 Summary of anthropometric and performance data used in the study. Variables in bold font were excluded due to high collinearity

Data category	Data [Unit of measure]
Anthropometric data	Age [years]
	Weight [kg]
	Height [cm]
	Waist circumference [cm]
	Shoulder circumference [cm]
	Torso circumference [cm]
	Hip circumference [cm]
	<i>Dominant hand wrist circumference [cm]</i>
	Weekly training hours [h]
Exercise performance	Running 30 m [s]
	<i>Running 60 m [s]</i>
	Rope 30 s [no. rep.]
	<i>Rope 60 s [no. rep.]</i>
	Height [cm]
	<i>Sergeant [cm]</i>
	Pull-ups [no. rep.]
	Chin-ups [no. rep.]
	Sit-ups [no. rep.]

no. rep. number of repetitions

Materials and methods

Subjects

A total of 56 children, aged 8–11 years old, were included in this study: 29 performed a program training of classical dance exercises (D group) and the remaining 27 performed a mixed training characterized by classical dance exercises alternated by rhythmic gymnastics (D&R group).

All the children had performed 2 years of classical dance before inclusion in the present study, which comprised training of at least 4 h per week. The two groups were monitored prior to training (T1) and after 1 year (T2) of training. Children in both groups attended four lessons a week. The typical training D group was engaged with involved typical exercises of ballet dance training, such as plié, battements, relevé jumps, tour, arabesque and stretching, alternated with modern dance training. D group trained with a one-sided, nondiversified method consisting of two ballet lessons and two modern dance lessons. Instead, the D&R group

trained with a diversified and multidisciplinary methodology, using indoor training that included classical, modern and acrobatic dance, modern, rhythmic gymnastics, back-strength training and small weights exercises and hip hop and outdoor training consisting of running and cycling.

The exclusion criteria were the presence of acute and/or chronic pathological states, pharmacological treatments and to exclude previous history of injury. The parents provided informed consent to participate to the study.

Anthropometric measurements

Data were collected through on-site evaluation of both anthropometric and exercise performance of the two groups (R&D and D) at two different times, called T1 and T2. Data collected are reported in [Table 1](#). Anthropometric measurements were collected in triplicate, as described in the following section. Height was measured with a fixed stadiometer (± 0.1 cm, Holtain Ltd., Crosswell, UK) and every subject was measured three times according to Cameron (1993). Body weight (in kilograms, kg), was measured at fasting state in the morning with a mechanical balance (SECA 700, Hamburg, Germany). Body mass index (BMI) was calculated as body weight divided by height squared (kg/m^2). BMI of each individual was converted using Italian reference tables. The values obtained were normally distributed from the 15th to 85th percentile of Cacciari's curve (Cacciari et al., 2006). The wrist circumference of the dominant hand side was measured immediately proximal to the ulnar and radial epicondyles to the nearest 0.5 cm. The mean calculated for triplicates was considered for statistical analysis.

The two groups had a similar weekly training volume (D group: 8.97 ± 2.16 h per week, D&R group: 9.09 ± 0.62 h per week at T1 and D group: 8.48 ± 1.74 h per week, D&R group: 9.13 ± 0.22 h per week at T2), as shown in [Table 2\(a\)](#).

Motor tests

The selected motor tests, validated by the Comitato Olimpico Nazionale Italiano (CONI; Merni & Carbonaro, 1981), are described as follows:

Running test 30–60 m

Starting from an upright position and without the support of the blocks, the subject is asked to go as fast as possible for 30 or 60 m. Elapsed time was measured with a chronometer. Three tests were executed, with a recovery time of 5–6 min. The best time, expressed in seconds, was chosen.

Sergeant test

The Sergeant test was selected to measure the explosive strength of lower limbs and performed according to Dumith, Van Dusen, and Kohl (2012). The subject attempts to touch the wall at the highest point of the jump. The distance between the jump height and the floor is recorded.

Rope test 30–60 s

The rope test, based on the measurement of the number of hops with the jumping rope, was carried out in 30 or 60 s according to Bianco et al. (2015).

Push-ups

The push-up test used to evaluate the upper body strength, power and muscular endurance was performed as follows: starting from prone position, with a flexion of shoulders and elbows, the subject tries to lower the entire body. Number of push ups performed by the subject in 1 min were measured.

Chin-up

The chin-up test, evaluating the strength and resistance of an individual's upper body was conducted as follows: subject holds a traction bar or a Swedish espalier, helped by the operator with a supine grip. Hands are placed at a distance equal to the shoulder's width. The subject flexes the arms until the chin reaches the grip line at the bar and returns to the starting position without touching the floor or any supports. The number of chin-ups performed in 1 min were counted.

Sit-up test

The sit-up test, measuring the strength and endurance of the abdominals and hip-flexor muscles, was performed according Merni and Carbonaro (1981).

Statistical analysis

The research design did not allow a random assignment of subjects, since the two groups were chosen between two preformed classes. In order to limit the influence of pre-existing differences among groups and avoid as far as possible the contamination by confounding variables, only the variation of anthropometric and exercise performance data was taken into account in order to draw conclusions on differences due to the training program. The two groups showed continuity in their training and, therefore, the same subjects were monitored at T1 and T2; thus no missing data is present.

The dependent variables (anthropometric and exercise data) were measured before and after the program, and each group was subjected to one level of the independent variable (D or D&R); therefore, the most appropriate design is a pretest–posttest between the groups; the impossibility of performing a randomization of the two groups led to the choice of a quasi-experiment design, with a nonequivalent control group. While this design represents the best solution when two groups form a natural entity, one of the main limitations is the lack of the ability to control the possible influence of external variables. The research design aimed to evaluate the variations between T1 and T2 time in the two groups, following a typical quasi-experiment design (Di Nardo, 2010) divided in the following steps:

- Anthropometric data and exercise performance were tested separately for collinearity using Belsley's collinearity diagnostics (Belsley et al., 1991) and variables that showed high collinearity were excluded from the study, in order to reduce the statistical tests performed;
- Shapiro–Wilk test was used on the remaining variables to confirm the normality of data distribution (Shapiro & Wilk, 1965);

- One-way ANOVA tests were performed between D and D&R data on the noncollinear variables at time T1;
- Holm–Bonferroni corrections were applied if a comparison yielded a statistically significant difference, in order to reduce family-wise type I errors, recalculating the p -values taking into account multiple comparisons (Holm, 1979);
- One-way ANOVA was performed on the variation of anthropometric and performance data from time T1 to time T2 between the two groups;
- Holm–Bonferroni corrections were applied to the results;
- The power of each test was also analysed, by comparing the observed F-statistic value and the expected F-statistic using the numerator degrees of freedom, denominator degrees of freedom and the Holm–Bonferroni corrected significance level. MATLAB 2020a (MathWorks, MA, USA) was used for all analysis.

Validity of the study

The quasi-experiment design allows to control much of the factors involved in internal and external validity in a similar fashion to true experiments. However, the lack of randomization leads to a lower internal validity of the study, compared to true experiments. This fact is confirmed by the comparison of anthropometric data at T1 (Table 2a).

Maturation, instrumentation, and treatment effects are also controlled in this design, since the two groups have similar age and share the same training field. Some limitations on internal validity therefore arise when analysing anthropometric data. The external validity is however not compromised by this research design; in addition, it presents the great advantage of respecting the group integrity without placing the subjects in a laboratory environment.

Results

First, all the data collected were used to study the collinearity of all the different dependent variables, in order to include only the noncollinear ones using Belsley's

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Evaluation of two different 1-year training programs among prepuberal female children

Abstract

The aim of this study was to analyse and compare the effects of two different dance training concepts in terms of anthropometric indices and supervised motor test performance between two groups of 56 prepuberal girls. The first group, composed of 29 girls, performed a typical classical dance training program (D group), while the second one, composed of 27 girls, followed a mixed training (D&R group) workout, with classical dance exercises alternated to rhythmic gymnastics. Anthropometric and exercise performance data were collected and assessed initially (T1) and after a 1-year (T2) training program. Data collected were firstly tested for collinearity using Belsley's test and, after their normality was tested through the Shapiro–Wilk test, analysis of variance (ANOVA) tests were performed on a subset of noncollinear variables. The two groups showed improvements in both anthropometric parameters and exercise performance; however, no differences arose between the variation of anthropometric parameters between the two groups. On the other hand, exercise performance was improved in some fields of the D&R group, particularly in exercises regarding the upper body, such as pull-ups, chin-ups and sit-ups. In conclusion, our data provide evidence that a specific training program consisting of classic dance plus rhythmic gymnastics exercises (D&R) has a greater impact compared to a program of simple classic dance, in terms of skill performance without impairment of anthropometric parameters.

Keywords

Classical dance · Rhythmic gymnastics · Female students · Motor skills · Exercise performance

collinearity test. Variables with a variance decomposition proportion greater than 0.5 and with a condition index higher than 30 were excluded from subsequent analysis in order to provide meaningful insight using noncorrelated quantities for

Table 2 Mean anthropometric data at T1 and T2 with standard error, mean difference between groups with 95% confidence bounds, together with analysis of variance (ANOVA) test results

(a) Anthropometric data T1							
–	Age	Weight	Waist	Shoulder	Torso	Hips	WTH
D group mean	9.62 ± 0.26	40.27 ± 1.65	67.10 ± 1.32	89.83 ± 1.41	74.52 ± 1.31	82.24 ± 1.51	8.97 ± 2.16
D&R group mean	9.45 ± 0.27	30.59 ± 1.71	59.04 ± 1.37	83.48 ± 1.47	67.78 ± 1.36	71.44 ± 1.57	9.09 ± 0.32
Mean difference	0.18 ± 0.75	9.68 ± 4.77	8.07 ± 3.82	6.35 ± 4.08	6.74 ± 3.79	10.80 ± 4.37	–4.26 ± 0.89
<i>F</i> (1, 54)	0.23	16.53	17.89	9.71	12.68	24.50	92.67
<i>p</i> -value ^a	0.63	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
H-B alpha	0.025	0.0063	0.005	0.01	0.0083	0.0045	0.0038
Power	–	0.85	0.87	0.58	0.73	0.97	1
(b) Anthropometric data T2							
–	Age	Weight	Waist	Shoulder	Torso	Hips	WTH
D group mean	10.39 ± 1.76	42.27 ± 10.91	68.45 ± 7.83	91.31 ± 9.02	76.03 ± 8.38	84.27 ± 9.80	8.48 ± 1.74
D&R group mean	10.47 ± 1.10	32.91 ± 5.93	58.11 ± 4.33	85.57 ± 5.57	69.96 ± 6.17	72.22 ± 5.65	9.13 ± 0.22
Mean difference	–0.08 ± 0.79	9.37 ± 4.75	10.33 ± 3.42	5.74 ± 4.05	6.07 ± 3.97	12.05 ± 4.32	–8.07 ± 1.10
<i>F</i> (1, 54)	0.042	15.59	36.64	8.06	9.41	31.17	214.86
<i>p</i> -value ^a	0.84	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
H-B alpha	0.05	0.0083	0.005	0.0167	0.01	0.0056	0.0038
Power	–	0.85	1	0.54	0.55	1	1

^a*P*-values lower than the H-B corrected alpha are in bold

testing and reducing the number of multiple comparisons to perform. Belsley's collinearity test showed that height and wrist circumference have high collinearity and were thus excluded from the analysis; among exercise performance, the test excluded from the dataset the following exercises: rope 30 and 60 s, height and the sergeant test (■ Figs. 1 and 2).

Comparison of anthropometric variations between D and D&R after 1 year training

Mean data from the D and D&R groups are shown in ■ Tables 2 and 3. After the normal distribution was confirmed by the Shapiro–Wilk test, one-way ANOVA tests were performed on the noncollinear variables in order to test the equivalence of the two groups at time T1. The results of the tests at T1 are reported in ■ Tables 2a and 3a. The two groups were nonequivalent for many of the anthropometric and exercise data with very high power; thus, in order to compare the effect of the different training between the two groups, only the variations of anthropometric and performance data between T1 and T2 were compared.

■ Table 4 shows that the anthropometric data variations are statistically

not significant. On the other hand, exercise performance shows statistically significant variations for pull-ups ($d = -1.93 \pm 0.83$, $F(1, 54) = 21.92$, $p = 1e-5$), chin-ups ($d = -0.72 \pm 0.35$, $F(1, 54) = 17.00$, $p = 1.3e-4$) and sit-ups ($d = -6.12 \pm 0.84$, $F(1, 54) = 44.21$, $p = 1.5e-8$), while performances related to stamina do not show statistically significant variations (i.e. 30 m run, 30 s rope and height; ■ Table 5).

Despite the quasi-experiment design not allowing us to draw conclusions on the differences between the raw performance values of the two groups at T1 and T2, for the sake of completeness, anthropometric and exercise data at T2 are reported in ■ Tables 6 and 7. The two samples resulted statistically different at T2 for all the exercises except for the Sergeant test.

Discussion

Exercise has beneficial effects, regardless of the specific type of activity. However, specific training programs can differentially impact physical performance and anthropometrical parameters. The present study aimed at analysing if and how two different long-term, regular and structured physical activity pro-

grams have an impact on performance and anthropometrical values of prepubertal girls. Although the main limitation of the study is the relative low number of tested subjects, our data showed that a specific training program consisting of classic dance plus rhythmic gymnastics exercises (D&R) has a greater impact compared to a program of simple classic dance, in terms of skill performance without impairment of anthropometric parameters.

The usefulness of physical activity in well-being promotion is widely recognized in healthy subjects as well as in several pathological conditions (Elce et al., 2018; Adami, Negro, Lala, & Martelletti, 2010; Corbi et al., 2019; Reilly et al., 2006). In individuals in prepubertal and pubertal age, physical activity is considered necessary to support growth, as well as motor skills.

Dance performance requires not only lower extremity muscle strength and endurance, but also enough core stabilization during dynamic dance movements. Rhythmic gymnastics is a sport that combines technical, aesthetic, and artistic parameters with the aim of reproducing an optimal execution model, both in form and execution (Díaz-Pereira et al., 2014). In our cohort of girls, both sport ac-

Fig. 1 ▲ Variance decomposition of anthropometric data. WTH weekly training hours

Fig. 2 ▲ Variance decomposition of exercise performance

tivities resulted in an improvement in motor skills, as suggested by the variations of exercise performance between times T1 and T2. However, the D&R group showed a statistically significant increase in performance of exercises involving core muscles, such as pull-ups, chin-ups and sit-ups, therefore suggesting that combining dance with rhythmic gymnastics could have greater impact on the children in terms of core strength and endurance, compared to dance classes. To the best of the authors' knowledge, there are no studies comparing motor abilities in dance activity and rhythmic gymnastics and, therefore, this study helps to cover an unexplored field, despite the lack of random assignment to the two different training programs. Watson et al. (2017) examined the impact of a 9-week core stabilization program on indices of dance performance, balance measures, and core muscle performance in competitive collegiate dancers and found significant improvements in single leg balance in *passé relevé*, number of pirouettes, and all measures of strength. Similarly, Srhoj et al. (2006) found that four different types of dance improve motor abilities in 78 female students. The authors conclude that dance is an irreplaceable educational tool in kinesiological education of female students, thanks to its considerable contribution to the development and maintenance of basic motor abilities. Although it is quite difficult to compare different sport activities as the motor abilities developed are specifically linked to the type of training, Auvinen et al. (2008), analysing the associations between participation in different sports and exercise activities and neck, shoulder, and low back pain in adolescents, concluded that participation in several sports seems to protect from harmful effects of a single risk sport. Similarly, our study demonstrates that an integrative approach of classical ballet plus gymnastic training allows female students to achieve their best performance, although we cannot conclude that dance is the best sport overall.

Our data also demonstrate that dance, despite of the type of training, does not differently impact on anthropometrical parameters. In contrast with these

Table 3 Mean exercise performance data at T1 and T2 with standard error, mean difference between groups with 95% confidence intervals, together with analysis of variance (ANOVA) test results

(a) Exercise performance data						
–	Run 30 m	Rope 30 s	Height	Pull-ups	Chin-ups	Sit-ups
D group mean	7.39 ± 0.17	12.90 ± 2.01	137.31 ± 2.22	2.31 ± 0.7207	0.52 ± 0.20	23.27 ± 1.41
D&R group mean	6.72 ± 0.18	32.04 ± 2.08	138.78 ± 2.30	6.26 ± 0.75	1.04 ± 0.21	31.59 ± 1.46
Mean difference	0.67 ± 0.49	–19.14 ± 5.80	1.47 ± 6.42	3.95 ± 2.08	–0.52 ± 0.58	–8.32 ± 4.07
<i>F</i> (1, 54)	7.31	43.71	0.21	14.47	3.17	16.75
<i>p</i> -value ^a	<0.01	<0.01	0.65	<0.01	0.08	<0.01
H-B alpha	0.0125	0.0042	0.05	0.0071	0.0167	0.0056
Power	0.44	0.99	–	0.79	–	0.84
(b) Exercise performance data						
–	Run 30 m	Rope 30 s	Sergeant	Pull-ups	Chin-ups	Sit-ups
D group mean	6.66 ± 0.80	15.52 ± 11.81	142.2 ± 14.00	3.83 ± 3.35	0.69 ± 1.26	28.38 ± 9.01
D&R group mean	5.65 ± 0.69	38.26 ± 12.19	143.78 ± 9.85	9.70 ± 5.75	1.93 ± 1.77	42.81 ± 7.02
Mean difference	1.01 ± 0.38	–22.74 ± 3.17	–1.57 ± 2.29	–5.88 ± 0.83	–1.24 ± 0.35	–14.43 ± 1.84
<i>F</i> (1, 54)	25.15	50.23	0.23	22.21	9.15	44.26
<i>p</i> -value ^a	<0.01	<0.01	0.63	<0.01	<0.01	<0.01
H-B alpha	0.0063	0.0042	0.0250	0.0071	0.0125	0.0045
Power	0.98	1	–	0.96	0.58	1

WTH weekly training hours

^a*P*-values lower than the H-B corrected alpha are in bold

Table 4 Variation of anthropometric data for both groups between T1 and T2, mean difference between groups with standard errors, together with analysis of variance (ANOVA) test results

Anthropometric data variation between T1 and T2							
	Age	Weight	Waist	Shoulder	Torso	Hips	WTH
D group mean variation	0.77 ± 0.11	2.00 ± 0.63	1.34 ± 0.70	1.48 ± 0.68	1.52 ± 0.59	2.03 ± 0.69	0.45 ± 0.23
D&R group mean variation	1.02 ± 0.11	2.31 ± 0.65	–0.93 ± 0.73	2.09 ± 0.70	2.18 ± 0.61	0.78 ± 0.72	4.27 ± 0.23
Mean variation difference	–0.26 ± 0.32	–0.31 ± 1.81	2.27 ± 2.03	–0.61 ± 1.95	–0.67 ± 1.70	1.26 ± 2.00	–3.81 ± 0.65
<i>F</i> (1, 54)	2.59	0.12	5.05	0.39	0.62	1.58	136.57
<i>p</i> -value ^a	0.11	0.72	0.03	0.53	0.43	0.21	<0.01
H-B alpha	0.0083	0.0250	0.0063	0.0167	0.0125	0.0100	0.0038
Power	–	–	–	–	–	–	1

^a*P*-values lower than the H-B corrected alpha are in bold

data, Liiv et al. (2013) examined variables between classical ballet dancers, contemporary dancers, and dancesport dancers concluding that dancers are generally more muscular than their ballet counterparts, while dancesport dancers are taller and heavier, less muscular, with slightly greater adiposity compared to the classical ballet dancers. Ballet dancers had the lowest body fat percentage, weight, and BMI values. It should be noted, however, that Liiv et al. (2013) considered professional athletes with a different training program and the volume of exercise compared to our female athletes. In addition, a limitation of the present study is the relative short period of training; further studies are

needed to clarify the anthropometric effects of the two training programs in female athletes in a longer follow-up period to unequivocally exclude negative effects of both programs.

Conclusions

It is widely recognized in literature that there is a significant relationship between the level of sport activity and all indicators of well-being (Ferron, Narring, Caudey, & Michaud, 1999). In particular in puberty, sport activities facilitate physical growth, the development of secondary sexual characteristics, and the maturation of psychosocial skills (Brown, Patel, & Darmawan, 2017). Results in

this work show that a regular and structured physical program including dance training and rhythmic gymnastics significantly improves core performance and abilities of female children compared to a simple dance training program, without exerting negative effects on anthropometrical parameters. This suggests that dance training and rhythmic gymnastics program is desirable for adolescents to improve their physical activity pattern and to enhance their fitness and muscle strength. However, our study includes only prepubertal girls and further studies including male dancers and/or professional dancers are needed. In addition, follow-up studies could also be carried out on the same subjects over

Table 5 Variation of exercise performance for both groups between T1 and T2, mean difference between groups with standard errors, together with analysis of variance (ANOVA) test results

	Exercise performance variation between T1 and T2					
	Run 30 m	Rope 30 s	Height	Pull-ups	Chin-ups	Sit-ups
D group	-0.73 ± 0.13	2.62 ± 1.10	4.41 ± 0.79	1.52 ± 0.29	0.17 ± 0.12	5.10 ± 0.6
D&R group	-1.07 ± 0.14	6.22 ± 1.14	4.61 ± 0.82	3.44 ± 0.30	0.89 ± 0.13	11.22 ± 0.66
Difference	0.34 ± 0.38	-3.60 ± 3.17	-0.19 ± 2.29	-1.93 ± 0.83	-0.72 ± 0.35	-6.12 ± 0.84
<i>F</i> (1, 54)	3.19	5.19	0.03	21.92	17.00	44.21
<i>p</i> -value ^a	0.08	0.027	0.86	<0.01	<0.01	<0.01
H-B alpha	0.0071	0.0056	0.05	0.0045	0.005	0.0042
Power	–	–	–	0.94	0.84	0.99

^a*P*-values lower than the H-B corrected alpha are in bold**Table 6** Mean anthropometric data at T2 with standard error, mean difference between groups with standard errors, together with analysis of variance (ANOVA) test results

	Anthropometric data						
	Age	Weight	Waist	Shoulder	Torso	Hips	WTH
D group mean	10.39 ± 1.76	42.27 ± 10.91	68.45 ± 7.83	91.31 ± 9.02	76.03 ± 8.38	84.27 ± 9.80	8.48 ± 1.74
D&R group mean	10.47 ± 1.10	32.91 ± 5.93	58.11 ± 4.33	85.57 ± 5.57	69.96 ± 6.17	72.22 ± 5.65	9.13 ± 0.22
Mean difference	-0.08 ± 0.79	9.37 ± 4.75	10.33 ± 3.42	5.74 ± 4.05	6.07 ± 3.97	12.05 ± 4.32	-8.07 ± 1.10
<i>F</i> (1, 54)	0.042	15.59	36.64	8.06	9.41	31.17	214.86
<i>p</i> -value ^a	0.84	0.0002	1.4e-7	0.0064	0.0034	7.86e-7	1.06e-10
H-B alpha	0.05	0.0083	0.005	0.0167	0.01	0.0056	0.0038
Power	–	0.85	1	0.54	0.55	1	1

^a*P*-values lower than the H-B corrected alpha are in bold**Table 7** Mean exercise performance data at T2 with standard error, mean difference between groups with standard errors, together with analysis of variance (ANOVA) test results

	Exercise performance data					
	Run 30 m	Rope 30 s	Height	Pull-ups	Chin-ups	Sit-ups
D group mean	6.66 ± 0.80	15.52 ± 11.81	142.2 ± 14.00	3.83 ± 3.35	0.69 ± 1.26	28.38 ± 9.01
D&R group mean	5.65 ± 0.69	38.26 ± 12.19	143.78 ± 9.85	9.70 ± 5.75	1.93 ± 1.77	42.81 ± 7.02
Mean difference	1.01 ± 0.38	-22.74 ± 3.17	-1.57 ± 2.29	-5.88 ± 0.83	-1.24 ± 0.35	-14.43 ± 1.84
<i>F</i> (1, 54)	25.15	50.23	0.23	22.21	9.15	44.26
<i>p</i> -value ^a	6.07e-6	3.08e-9	0.63	1.76e-05	0.0038	1.52e-8
H-B alpha	0.0063	0.0042	0.0250	0.0071	0.0125	0.0045
Power	0.98	1	–	0.96	0.58	1

^a*P*-values lower than the H-B corrected alpha are in bold

longer periods of training activity to unequivocally exclude negative impact on physical parameters. In conclusion, our findings suggest that a combined training method, characterized by exercises from ballet dance and rhythmic gymnastics, is preferred over dance training with only ballet because it improves motor skills in children, guaranteeing the best outcome.

More analyses, based on our results, will overcome the limitations of this study and increase the internal validity of the results.

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Funding. Open access funding provided by Università degli Studi della Campania Luigi Vanvitelli within the CRUI-CARE Agreement.

Declarations

Conflict of interest. A. Elce, R. Polito, A. Del Pizzo, G. Di Rauso, F. Guarino, A. Sangiorgio, A. Daniele and E. Nigro declare that they have no competing interests.

For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case.

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