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ORIGINAL RESEARCH

How does artistic gymnastics and trampoline gymnastics training affect dynamic balance, abdominal strength, jump performance, and flexibility in adult females?

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Abstract

Background: Artistic gymnastics and trampoline gymnastics are an enormously popular group of sports that develops many biomotor skills, however, their effect on various aspects of fitness is not sufficiently observed. **Objective:** The study aimed to determine the effects of artistic gymnastics and trampoline gymnastics training on body composition, balance, jump performance, abdominal strength, and flexibility in adult females. **Methods:** Fifty-one adult female non-gymnasts (age 19.59 ± 1.58 years, height 160.69 ± 4.74 cm) were randomly assigned to three groups: the artistic gymnastics group (n = 19), the mini-trampoline gymnastics group (n = 16), and the control group (n = 16). The training groups performed either artistic gymnastics or mini-trampoline training twice a week for 12 weeks. The control group only did warm-up exercises twice a week during the study. The measurements to determine the effects of different gymnastics training on body composition, dynamic balance, jump performance, abdominal strength, and flexibility were performed before and after the exercise programs. The pre-test and post-test of the variables of groups were compared using paired sample t-test. A one-way analysis of variance was used for between-group comparisons. **Results:** Both artistic gymnastics and trampoline gymnastics trainings significantly improved the dynamic balance, vertical and standing long jump, abdominal strength, and flexibility compared to the control group (p < .05). There were significant differences between the artistic and trampoline gymnastics groups for almost all performance tests (p < .05), but no significant difference in flexibility tests. Trampoline gymnastics training provided more improvement than artistic gymnastics training in all performance variables except flexibility (p < .05). **Conclusions:** The findings of the study indicated that both gymnastics trainings improved all performance variables. However, mini trampoline training seems to be more effective than artistic gymnastics training in all performance variables except flexibility.

Keywords: gymnastics, abdominal strength, balance, jump, flexibility

Introduction

Gymnastics is a sport that consists of artistic, aerobics, acrobatics, trampoline, rhythmic, and general gymnastics. Specifically, trampoline gymnastics is divided into individual trampoline, synchronized trampoline, double mini-trampoline, and tumbling. Trampoline gymnastics benefits, including enhanced strength, endurance, balance, and proprioceptive development related to health, are an important advantage for daily life utilities (Maxson & White, 2009). In addition, some of the studies (Aragão et al., 2011; Giagazoglou et al., 2013; Stanghelle et al., 1988) reported that using trampoline gymnastics training indicated useful results, including increasing maximal oxygen uptake, improving motor and balance ability, and enhance the rate of hip moment generation and balance in some groups of children with cystic fibrosis, and children with intellectual disability, and elderly people.

The maintaining of balance (Chander & Dabbs, 2016), the ability to jump (Baker, 1996; Davis et al., 2003, Luebbers et al., 2003), core muscle strength, and flexibility (Granacher et al., 2014) are some of the important components for humans both in daily life and in many sports (Chander & Dabbs, 2016). Dynamic balance is defined as a skill of an individual to maintain the stability of the center of mass during movement, and it is known as an important component to examine in relation to injury risk (Butler et al., 2012). The maintenance of balance may be affected by multiple factors, including sensorimotor function, central integration, total body mass, aging, speed of walking, fatigue, etc. (Chander & Dabbs, 2016). In addition, several factors, including muscular force production, jump technique, joint mobility, age, body composition, weight, and height, are thought to contribute to vertical jump performance (Davis et al., 2003). Core muscle strength, and health and skill-related components of physical fitness, including strength, flexibility, balance, coordination, and speed, may be improved potentially by using core strength training (Granacher et al., 2014).

To our knowledge, there is a limited amount of published studies regarding the effects of artistic gymnastics

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training and trampoline gymnastics training for males. Besides, no study has been found on the effects of artistic and trampoline gymnastics training on females. Therefore, the purpose of this study is to compare the effects of two different gymnastics training that practiced on different surfaces. Therefore, the study was conducted to determine the effects of artistic gymnastics and mini-trampoline gymnastics on body composition, dynamic balance, jump performance, abdominal strength, and flexibility in females.

Methods

Participants

Fifty-one recreationally active females (age 19.59 ± 1.58 years, height 160.69 ± 4.74 cm) who did not participate in any regular gymnastics training before, took part in this study voluntarily. Before starting the study, all participants were given information sheets and signed an informed consent form. The study was approved by the Ethical Committee of Hitit University (decision no. 2021-73).

Procedures

The participants were randomly divided into three groups: artistic gymnastics group (A), trampoline gymnastics group (T), and control group (C). The exercises lasted twelve weeks for all groups. All participants performed two training sessions each week. While the participants who took part in gymnastics groups (A, T) performed their exercise programs, the control group took part only in the warm-up and cool-down sessions.

The training protocols

All participants performed two training sessions each week. All participants performed warm-up and cool-down exercises. The warm-up exercises consisted of 5 minutes of walking and jogging followed by 10 minutes of stretching exercises for the upper and lower body extremities at the beginning of each training session. The cool-down exercises consisted of 5 minutes of jogging at the end of each training session.

Artistic gymnastics training

Participants in the A group performed 30-minute training programs that included gymnastics exercises requiring forward and backward flexibility, strength, and coordination on a floor mat following the warm-up protocol. The difficulty of exercises in the training program progressively increased each week. Participants performed each movement twelve times on a gymnastics floor mat (Rollable Mat "Flexi-Roll"; Spieth Gymnastics, Altbach, Germany) in one session. The 90-second rest was given between repetitions. The weekly schedule of artistic gymnastics training is shown in Table 1.

Trampoline gymnastics training

Participants in the T group performed 30-minute training programs which required flexibility, strength, and coordination that basic jumps, landing, rolling, and twisting exercises from the mini trampoline to the mat The difficulty of exercises in the training program progressively was increased for each week. Participants performed each movement 12 times on a mini trampoline (Minitramp 112/125; Eurotramp Trampoline, Weilheim an der Teck, Germany) in one session. The 90-second rest was given between repetitions. The weekly schedule of mini-trampoline gymnastics training is shown in Table 2.

Testing

In this study, all tests were conducted in pre- and post-study in three sessions, each session on a separate day. A familiarization phase was performed one week before the pre-tests. Participants performed performance tests in the familiarization phase. The body mass, height, and body composition were obtained in the first session. The flexibility and abdominal muscle strength tests were conducted in the second session. Dynamic balance and jumps tests were done in the third session. The participants were instructed not to consume any stimulants and to avoid any exercise before performance tests. They performed 5 minutes of running and 2 minutes of walking before the performance tests.

Body composition

Seca 213 stadiometer (Seca, Hamburg, Germany) was used to measure participants' body heights and the Tanita BC-418 body composition analyzer was used to obtain the participants' body mass and body fat.

Table 1 Artistic gymnastics training program

Week	Exercise
1	Forward-backward roll
2	Forward-backward straddle roll
3	Handstand with help
4	Handstand walk
5	Cartwheel over the mini ramp
6	Cartwheel with help
7	Handstand to bridge and front walkover
8	Front handspring with help on the soft floor
9	Hurdle cartwheel
10	Roundoff with help
11	Back walkover with help
12	Jumping to flat back and back handspring with help on barrel mat

Table 2 Trampoline gymnastics training program

Week	Exercise
1	Basic jumps on mini-trampoline
2	Exercises for the proper body position on the trampoline
3	High jump from mini-trampoline to the mat
4	Straight jump
5	Tucked jump
6	Straddle jump
7	Jumping with 180° twist
8	Jumping with 360° twist
9	Jump to handstand from mini-trampoline to high mat
10	Jump to handstand from mini-trampoline handstand roll on the mat
11	Dive roll to the mat
12	Salto forward from mini-trampoline to the mat

Flexibility

Sit and reach, trunk flexibility tests were used to obtain the flexibility scores of participants. The participant was seated on the flat floor, bare feet were allowed to rest flat on the test bench, then, the body was extended as far as it could reach forward, and the arms and fingers were stretched and straight. Participants were asked to wait for a second or two at the last point, and after two attempts, the best score was recorded (Tamer, 2000).

The trunk flexibility test was carried out as stated by Miller (2006). The trunk flexibility score was obtained by measuring the height of the chin from the ground.

Dynamic balance

The participants' dynamic balance performance was determined by using the Y balance test (Plisky et al., 2009). Participants performed the test barefoot. Participants stood on the footplate with one leg behind the starting line and they tried to reach a maximum distance along with the anterior, posteromedial, and posterolateral directions respectively (Plisky et al., 2009). The three scores which were performed successfully by participants for each direction were recorded in centimeters. The greatest score for each direction was used for calculations. The participants performed the same protocol for the other leg. Length of lower limb measurements was carried out and composite reach distance was calculated as stated by Plisky et al. (2006).

Abdominal muscle strength

Participants were asked to do sit-ups as much as they can repeat within 1 minute. The sit-up test was performed according to the protocol stated by Morrow et al. (2015). Attention was paid to ensuring that the shoulders of the participants touch the ground when they lie on the floor and that their elbows touch their knees when they straighten, and the number of sit-ups was recorded (Morrow et al., 2015).

Jumping

The participant's vertical jump heights were obtained by using a tape measure on the wall. The participant stood with the dominant side towards to wall. The participant's jump height was measured as the difference between the maximum height reached while standing and the maximum height reached when jumping. All participants performed 3 trials. The best trial was recorded (Sargent, 1921).

The participant's standing long jump performances were obtained by using a tape measure on the floor. The participant started to jump just behind the starting line with feet shoulder-width apart. The participant was asked to jump forward as far as possible with both feet by using an arm swing. The point where the participant stood after jumping was defined as the jump point. The difference between the starting line and the jump point was recorded as the standing long jump score. The participants performed three jumps and the best score was recorded in centimeters (Adam et al., 1987).

Statistical analysis

The data were described by mean ± standard deviation. All variables showed normal distribution according to the Shapiro-Wilk test except dynamic balance. The pre-test and post-test of body composition, flexibility, and jump performances of groups were compared by using paired sample *t*-test. The one-way analysis of variance was used among the groups to compare the difference in the post-test and pre-test. The differences between individual groups were determined by using the Tukey post-hoc test. The pre-test and post-test of dynamic balance scores of groups were compared by using Wilcoxon signed rank tests. The comparison between groups was carried out using the Kruskal Wallis test for the difference in post-test and pre-test dynamic balance scores. All statistical tests were performed using IBM SPSS (Version 25; IBM, Armonk, NY, USA). The significance level was set at $p < .05$.

Results

Table 3 presents the body composition changes in pre and post-training according to the different training types. There was a significant increase in body mass ($p < .001$, $r = .88$), body mass index ($p < .001$, $r = .88$), and body fat percentage ($p < .001$, $r = .90$) in C between pre and post-study. A significant increase in body mass index ($p = .045$, $r = .45$) and body fat percentage ($p = .007$, $r = .59$) was

Table 3 The changes in body composition

Variable/Group	Pre	Post	Difference	Δ%	*p*
Body mass (kg)					
Artistic gymnastics	57.23 ± 6.77	58.03 ± 6.63	0.80	1.40	.054
Trampoline gymnastics	53.29 ± 6.64	53.54 ± 6.32	0.25	0.47[a]	.377
Control	53.29 ± 6.36	54.81 ± 6.70	1.52	2.85	< .001
Body mass index (kg/m^2)					
Artistic gymnastics	22.18 ± 2.58	22.51 ± 2.65	0.33	1.49	.045
Trampoline gymnastics	20.88 ± 2.52	20.98 ± 2.50	0.10	0.48[a]	.331
Control	20.57 ± 2.08	21.15 ± 2.20	0.58	2.82	< .001
Body fat (%)					
Artistic gymnastics	21.48 ± 4.31	22.56 ± 4.22	1.08	5.03	.007
Trampoline gymnastics	18.62 ± 2.67	18.79 ± 3.08	0.17	0.91[a]	.581
Control	19.52 ± 3.46	20.98 ± 3.58	1.46	7.48	< .001

Note. [a]statistically significant difference with the control group.

seen in A. There were no statistically significant changes for all variables in T based on pre and post-test evaluations. According to comparing all groups, there were just significant differences in body mass (p = .026, η_p^2 = .141), body mass index (p = .035, η_p^2 = .131), and fat percentage (p = .013, η_p^2 = .165) values between the groups. With the Tukey post-hoc test significant differences were found between T and C, and no significant differences were found between A and C, T and A.

Table 4 presents the changes in performance and flexibility components within-group between the pre and post-training based on the different training protocols. In A and T, a significant improvement was found for all variables, but there was a significant impairment in C (p < .05). Table 4 presents also the comparison of change among three groups according to the variables. There were statistically significant differences in dynamic balance right (p < .001, η_p^2 = .844), dynamic balance left (p < .001, η_p^2 = .872), vertical jump (p < .001, η_p^2 = .746), standing long jump (p < .001, η_p^2 = .869), abdominal strength (p < .001, η_p^2 = .881) among all groups (p < .05). There was a significant difference in the hamstrings and lumbar spine flexibility (p < .001, η_p^2 = .859) as well as trunk-neck flexibility (p < .001, η_p^2 = .872) among the groups. According to the post-hoc test, there was a significant difference between the training groups (T and A) and the control group (p < .05), but no difference was found in the training groups (p > .05).

Discussion

The study mainly focused on the effects of artistic gymnastics versus mini-trampoline gymnastics on body composition, dynamic balance, vertical jump, standing long jump, abdominal strength, and flexibility performance in adult female non-gymnasts.

Based on the results of training protocols, body mass, body mass index, and body fat percentage showed statistically significant increases only in C. However, the lowest relative changes related in these three variables were found in the trampoline gymnastics group. Aalizadeh et al. (2016) found that a significant decrease in body fat percentage was seen in 20-week trampoline training performed in 11–14-year-old students and also had positive effective results in anaerobic performance. Witassek et al. (2018) reported that body fat percentage decreased to the rate of 5.4% after 8-week mini-trampoline training. The results are in agreement with our results. During the study, there was no daily nutrition intervention for the participants; they continued their daily routine nutrition habits. Therefore, based on these findings, we suggest that mini-trampoline or artistic gymnastics training, but especially mini-trampoline gymnastics, may be used for weight loss management. Trampoline gymnastics also may provide the keeping up the activity with enjoyment. However, for a clear conclusion, more studies may be conducted to highlight the effects on body composition components.

Table 4 The comparison of performance and flexibility variables

Variable/Group	Pre	Post	Difference	Δ%	p
Dynamic Balance Score, right					
Artistic gymnastics	88.00 ± 4.24	92.69 ± 3.47[ab]	4.69	5.33	< .001
Trampoline gymnastics	84.92 ± 4.64	97.70 ± 3.71[a]	12.78	15.05	< .001
Control	86.29 ± 4.16	84.83 ± 3.99	−1.46	−1.69	< .001
Dynamic Balance Score, left					
Artistic gymnastics	87.42 ± 3.10	91.35 ± 3.82[ab]	3.93	4.50	< .001
Trampoline gymnastics	82.97 ± 4.79	94.87 ± 3.74[a]	11.9	14.34	< .001
Control	83.83 ± 4.02	82.04 ± 3.97	−1.79	−2.14	< .001
Vertical jump (cm)					
Artistic gymnastics	33.26 ± 4.69	33.74 ± 4.53[ab]	0.48	1.44	.001
Trampoline gymnastics	33.69 ± 4.51	35.56 ± 4.35[a]	1.87	5.55	< .001
Control	33.63 ± 3.79	32.94 ± 3.64	−0.69	−2.05	< .001
Standing long jump (cm)					
Artistic gymnastics	167.11 ± 13.37	170.16 ± 13.08[ab]	3.05	1.83	< .001
Trampoline gymnastics	159.63 ± 15.34	169.50 ± 14.39[a]	9.87	6.18	< .001
Control	168.38 ± 16.17	164.56 ± 15.77	−3.82	−2.27	< .001
Abdominal strength (repetitions)					
Artistic gymnastics	35.47 ± 6.27	43.74 ± 5.35[ab]	8.27	23.32	< .001
Trampoline gymnastics	22.81 ± 7.32	34.00 ± 5.40[a]	11.19	49.06	< .001
Control	30.94 ± 8.54	26.88 ± 7.52	−4.06	−13.12	< .001
Sit and Reach (cm)					
Artistic gymnastics	28.68 ± 3.62	33.05 ± 3.01[a]	4.37	15.24	< .001
Trampoline gymnastics	29.56 ± 4.50	33.75 ± 4.37[a]	4.19	14.17	< .001
Control	29.19 ± 3.78	27.31 ± 3.72	−1.88	−6.44	< .001
Trunk flexibility (cm)					
Artistic gymnastics	42.05 ± 7.56	50.79 ± 7.74[a]	8.74	20.78	< .001
Trampoline gymnastics	41.06 ± 7.23	49.69 ± 7.05[a]	8.63	21.02	< .001
Control	43.19 ± 6.10	39.75 ± 6.02	−3.44	−7.96	< .001

Note. [a]statistically significant difference with the control group. [b]statistically significant difference with the trampoline gymnastics group.

The results of our study for both gymnastics training groups indicated a significant performance improvement in balance, vertical jump, standing long jump, core strength, and flexibility in pre and post-tests (A, T). But, in trampoline gymnastics training compared to artistic gymnastics training, a remarkable percentage increase was shown in dynamic balance values. Sadeghi and Baqlaei (2018) reported that underwater trampoline exercises improved by 65% and aquatic exercises improved by 20% the static balance. Aragão et al. (2011) stated that elderly participants regained balance improvement of about 35% after the mini-trampoline exercise for dynamic stability. Giagazoglou et al. (2013) noted that a significant performance improvement occurred in balance ability after 12 weeks of the trampoline training program in individuals with intellectual disabilities. Atilgan (2013) reported that the static and dynamic balance of boys was improved after 12 weeks of trampoline training. de Oliveira et al. (2014) reported that the postural balance was affected positively by 12 weeks of mini-trampoline, floor, and aquatic gymnastics training in elderly women. Boraczyński et al. (2013) stated that the static balance of girls aged 7 years was affected positively after 12 months of artistic gymnastics training by 36.77%. Our study results are supported by the studies (Aragão et al., 2011; Atilgan, 2013; de Oliveira et al., 2014; Giagazoglou et al., 2013; Sadeghi & Baqlaei, 2018) reporting improved balance ability after the practiced trampoline training intervention. Based on these findings, it can be said that trampoline gymnastics is a preferable method for improving dynamic balance performance.

The present study showed that both groups of gymnastics significantly increased vertical jump and standing long jump performance from the pre-values. Although both gymnastics training increased jumping performance, most of the increase occurred in T. But, in C that did not perform any of the gymnastics training, just warm-up, it was seen that vertical jump and standing long jump values decreased significantly. Witassek et al. (2018) stated that mini-trampoline training improved the jump height by 7.7% but not found statistically significant differences between pre and post-test. Atilgan (2013) reported that the boys, who did not apply any exercises, just 12 weeks of trampoline training, improved jump, and leg strength performance. Obreshkov and Simeonova (2012) noted that a six-month gymnastics training three times a week improved the ability to jump, flexibility, and speed considerably in children. Karakollukçu et al. (2015) reported that the jump performances of male gymnasts were positively affected by 12 weeks of trampoline exercises. Giagazoglou et al. (2013) stated that the 12 weeks of the trampoline training intervention program improved the jump performances of intellectual disability participants. These findings indicate that trampoline gymnastics training may provide improvement in jumping performance.

Another area of the study involves abdominal strength and flexibility. After 12 weeks of training, both training groups increased abdominal strength and flexibility significantly from baseline and when compared to the control group. Abdominal strength increased in T and A but decreased in C at the end of the study. Hamstrings and lumbar spine (sit and reach) flexibility and trunk-neck flexibility improved both in T and A but not in C. Boraczyński et al. (2013) reported that a 12-month artistic gymnastics training program improved the flexibility (hamstrings and lumbar spine) results by 43.55%. Giagazoglou et al. (2013) reported that twelve weeks of a trampoline training intervention program led to significant improvements in participants' flexibility (pre –13.11 ± 7.27, post –7.00 ± 6.52). Koca et al. (2019) stated that the mini-trampoline training performed for 15 minutes was more effective on muscle elasticity compared to the walking exercise performed for 15 minutes as a heating technique. When it takes into account all results in our study; it was seen that all variables in the control group were not improved compared to the other training groups. The reason could be that they did not participate in any exercise program except warm-up and cool-down.

Conclusions

The study findings indicate that mini-trampoline gymnastics training versus artistic gymnastics training is more effective for improving dynamic balance, vertical jump, standing long jump, and abdominal strength in adult females. However, both exercises can be used for flexibility development since similar improvements in flexibility were found in both groups. The coaches and athletes may consider especially mini-trampoline gymnastics training in their training schedule for sports branches that have importance for jumping, dynamic balance, abdominal strength, and flexibility parameters.

Conflict of interest

The authors report no conflict of interest.

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