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The Effect Of Plyometric And Tabata Training On Jump Performance, Respiratory Function Parameters On Aerobic Gymnasts

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Abstract

In this study, the effect of pliometric and tabata training applied to aerobic gymnasts between the ages of 12-14 on jump performance and respiratory function parameters was investigated. Actively competing in the study, mean age 12.8 ± 0.19 (year), average body weight 34.28 ± 1.46 (kg), average height 145.19 ± 2.29 (cm), average age for sports 7.14 ± 0.24 female gymnasts participated voluntarily. The subjects were randomly divided into 3 groups according to age groups. First group (A group), Technical + Pliometric training program, second group (B group), Technique + Tabata training program, third group (C group) control group applied only Technical training program. A total of 12 exercises were applied to the subjects for 6 weeks, 2 exercises per week. The subjects were tested for jump performance, 30 sec Bosco Test, respiratory function test and C group basic difficulty elements test, pre-test and post-test. In the evaluation of the data, analysis of variance was used in 3 x 2 repeated measures. The difference between the groups was determined by the Bonferroni test. As a result of the 6-week training, there was no significant difference in the control group according to the pre-test and post-test results, while in the pliometric training group and tabata training groups, active jump, 30 sec Bosco, tuck jump, cossack jump, pike jump and straddle jump group C There was a significant difference in performance, respiratory functions at FEV1 and FVC ($p<0.05$) levels, but no significance was found at other levels ($p>0.05$). As a result, it is recommended to trainers to use pliometric training for jumping strength and performance increase, tabata training method to increase the continuity of the series, reduce energy expenditure and increase anaerobic capacity.

Keywords: Aerobic Gymnastics, Plyometrics, Tabata, Respiratory Parameters

Aerobik Cimnastikçilere Uygulanan Pliometrik Ve Tabata Antrenmanlarının Sıçrama Performansı Ve Solunum Fonksiyon Parametreleri Üzerine Etkisi

Özet

Bu çalışmada 12-14 yaş arasındaki, aerobik cimnastikçilere uygulanan pliometrik ve tabata antrenmanlarının sıçrama performansı ve solunum fonksiyon parametreleri üzerine etkisi araştırılmıştır. Çalışmaya aktif olarak yarışan, yaş ortalaması 12,8±0.19 (yıl), vücut ağırlığı ortalaması 34,28±1,46 (kg), boy ortalaması 145,19±2,29 (cm), spor yaşı ortalaması 7,14±0,24 yıl olan 21 kadın cimnastikçi gönüllü olarak katılmıştır. Denekler rastgele yöntemle yaş gruplarına göre 3 gruba ayrılmıştır. Birinci grup

(A grubu), Teknik + Pliometrik antrenman programı, ikinci grup (B grubu), Teknik + Tabata antrenman programı, üçüncü grup (C grubu) kontrol gurubu sadece Teknik antrenman programı uygulamıştır. Deneklere 6 hafta boyunca, haftada 2 antrenman olmak üzere toplam 12 antrenman uygulanmıştır. Deneklere sıçrama performansı ölçümü, 30 sn Bosco Sıçrama Testi, solunum fonksiyon testi ve C grubu temel zorluk elementleri havada kalış süreleri testi, ön test ve son test olmak üzere yaptırılmıştır. Verilerin değerlendirilmesinde, 3 x 2 Tekrarlı ölçümlerde Varyans analizi kullanılmıştır. Gruplar arasındaki farklılık Bonferroni testi ile tespit edilmiştir. Yapılan 6 haftalık antrenmanların sonucunda, ön test ve son test sonuçlarına göre kontrol grubunda anlamlı farklılık bulunmazken, pliometrik antrenman gurubu ve tabata antrenman guruplarında, aktif sıçrama, 30 sn Bosco, tuck jump, cossack jump, pike jump ve straddle jump c grubu temel elementlerin sıçrama performanslarında, solunum fonksiyonlarında FEV1 ve FVC'de ($p<0.05$) düzeyinde anlamlı farklılık bulunmuş, diğer düzeylerde herhangi bir anlamlılık bulunmamıştır ($p>0.05$). Sonuç olarak antrenörlere, sıçramaya yönelik gücün ve performans artışının sağlanması için pliometrik antrenmanların, serinin devamlılığı, enerji harcamını azaltmak için ve anaerobik kapasiteyi arttırmak için tabata antrenman yönteminin kullanılması önerilmektedir.

Anahtar Kelimeler: Aerobik Cimnastik, Pliometrik, Tabata, Solunum Parametreleri

INTRODUCTION

Gymnastics sport is a branch of sport that depends on the ability to apply methodical, measured and regular exercises with intelligence and courage in its own competition equipment within the framework of certain rules. Although the training is divided into artistic, rhythmic and general branches; it consists of many movements and movement groups such as jumping, turning, handstand, leg and arm swings, flight, static stance (1). The advancement and development of technology provides an increase in scientific publications. The development of sports branches is in direct proportion to the increase in these characteristics. Gymnastics, which is one of these sports branches, is one of the sports branches that increase the number of success and medals with the development of technology. Gymnastics is a very difficult sport that requires the neuromuscular system to work optimally and efficiently. It includes exercises that require physical strength, flexibility, agility, coordination, balance, and grace (5). Many sports branches, in which perfectly developed biomechanical properties, neuromuscular properties and coordination features are used, ensure that athletes develop according to the development of their body structures and the desired characteristics in their branches, thus increasing the number of success of the athletes. Gymnastics has many sub-disciplines with these characteristics. One of these sub-disciplines is aerobic gymnastics. Aerobic gymnastics is the regular blending of the elements of difficulty, which are composed of aerobic step patterns spliced together, and required to be done according to the baton rule, accompanied by music prepared for the planned competition choreography and presented in accordance with the competition criteria (6). Aerobic gymnastics is a high-intensity branch that is perfectly integrated with music and can take place in anaerobic alatacid conditions. Due to the high speed of the choreography or series times (1.20 ± 5 seconds) and the tempo of the music (150-160 Bpm) of the competitors, the energy expenditure of the athletes in an anaerobic environment is high. Complex movements are expected to be applied, as the youngest and ever-expanding gymnastics branch is defined as an aesthetic technical discipline (7). High intensity interval training (HIIT) is one of the methods used to improve aerobic and anaerobic capacity. Although this method is used in endurance development, it quickly and effectively meets the need for adaptation and shortens the duration of exercise. HIIT, a training method that improves the cardiovascular system and metabolic functions, has recently made new and positive contributions for both sedentary and athletes in the perspective of positive adaptation, health and performance. Tabata, created as a result of a study conducted by Prof. Izumi Tabata et al at Tokyo National Institute of Fitness and Sports school, Tabata is a HIIT workout (2). The ability of the athlete to exhibit the movements in the choreography perfectly depends on his physical capacity. Determining the level of physiological characteristics and trying to increase them is extremely important in terms of performance as well as physical properties. The results of this study will give the trainers the opportunity to compare the effects of plyometric and tabata training on jump performance and respiratory function parameters in aerobic gymnasts performed at different times of the day, and will help in planning the training. It can be recommended to use the obtained test results well because it will provide significant positive effects on long-term health and performance levels of athletes.

METHOD

Subjects and Research Model

Actively in aerobic gymnastics competitions in Manisa Magnet Sports Club and Izmir Gencay Cüce Gymnastics and Dance Sports Club participated voluntarily. The subjects were informed about the possible risks and advantages of the study and gave their informed permission to participate in this study, which was approved by the Clinical Research Ethical Committee of Pamukkale University (60116787-020/4295). This study was supported by Pamukkale University Scientific Research Projects Coordination Unit (project number is 2018SABE011).

Data Collection

Anthropometric Measurements

The height of the subjects was measured by a stadiometer (Seca, Germany) with an accuracy degree of 1 mm and body weight measurements of 0.1 kg. After the anatomical position was taken, the measurement results were recorded in cm and kg.

Jump Performance Measurements

The subjects were measured with the Smart Speed mat and the best grades of the subjects were recorded. In active jumping, the subjects were initiated in an upright position with their arms free and carried out by lowering the arms and applying a rapid squatting motion and a rapid rising motion by pulling the arms up. In squat jump, subjects were applied with the knees bent approximately 90 degrees, with the subject's hands fixed on the hip and initially without a bowing motion. Measurements are recorded in cm. Subjects participating in the study were given two repetition rights. 15 seconds of rest is given between both jumps. One minute rest is given between the squat jump and the active jump.

30 sec Bosco Jump Test

The subjects were measured with the Smart Speed mat. The subject jumped on the mat and meanwhile time (0.001) started to work, time stopped when the athlete landed on the ground. Thus, the duration of the subject's stay in the air was calculated. In the test result of the subjects, the power was recorded in Watts.

Respiratory Function Test

Respiratory parameters (VC-vital capacity, FVC-forced vital capacity, MVV-maximum voluntary ventilation, FEV1-First second forced expiration volume) of the subjects were measured with a BTL-08 PC SPIRO brand portable spirometer. All measurements were taken while the subject was sitting. In spirometer measurements; The noses of the subjects were closed with a clip, and several breaths were made in tidal volume with the help of a mouthpiece connected to a spirometer. After getting accustomed to this type of breathing, the measurement was carried out. Each measurement was repeated 2 times and the best value was recorded (3).

Basic Difficulty Elements "Group C" Measurements

The C group main difficulty of the subjects, which are included in the jump and leap family, whose series are also used, is to determine the measurements of the elements (Tuck Jump, Cossack Jump, Pike Jump, Straddle Jump) before the test to determine the measurements of the elements (Tuck Jump, Cossack Jump, Pike Jump, Straddle Jump) they were informed. The subjects were measured with the Smart Speed mat and the best scores of the subjects were recorded. In the measurements, the air time of the subjects was recorded as milliseconds. After each measurement, the device was reset and the stability of the device was paid attention to. Subjects participating in the study were given two repetition. Both elements are given 15 seconds rest between jump. One minute rest was given between each element and the best result was recorded.

Elements

Tuck Jump

One or two feet are lifted from the ground. A vertical jump is made by moving the legs with the knees bent close to the chest, and the element is shown in the air and the feet are next to the ground.

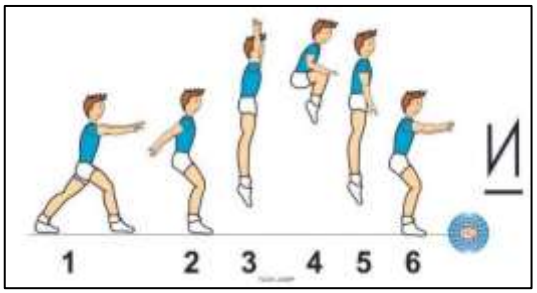

Figure 1. Tuck jump element

Cossack Jump

One leg is bent at the knee (cossack) and both legs are raised parallel to the ground or higher and vertical jump is made. The thighs of both legs are adjacent and the element is shown parallel to the ground and the feet are adjacent to the ground.

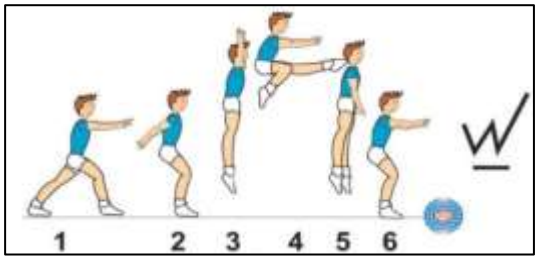

Figure 2. Cossack jump element

Pike Jump

It is done by doubling the body in the air by jumping vertically. Both legs are lifted from the ground and taken to a position parallel to the floor. Legs are parallel to the ground or higher than the ground, indicating an angle of no more than 60 ° between the trunk and legs. Arms and hands reach to the tip of the toes, showing the element and landing with the feet next to the ground.

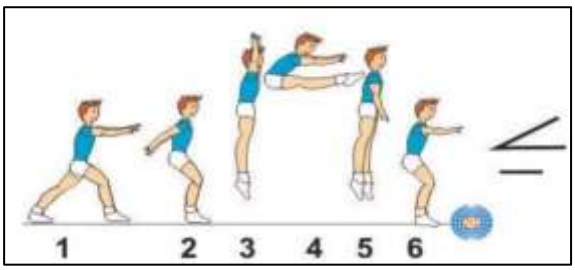

Figure 3. Pike jump element

Straddle Jump

Vertical jump is applied and the legs are lifted while in the air and the Straddle (legs in the air are opened with at least 90 ° width) position is taken with the arms. The angle between the body and legs is not more than 60 °, the legs are raised parallel to the ground or higher than the ground, the element is shown and the feet are adjacent to the ground.

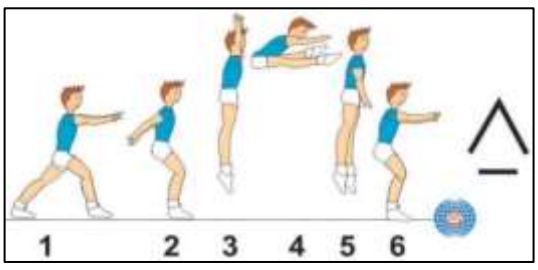

Figure 4. Straddle jump element

Test Protocol

Following the application of pre-test protocols applied after 48 hours of rest in 1 week, the subjects were divided into 3 groups in a way to ensure equality according to pre-test, age, height and performance status. Training programs were applied to the athletes for 6 weeks, 2 days a week, Monday and Thursday. While the Pliometric + Technique and Tabata + Technique trainings were applied right after the warm-up, the 3rd Group determined as the control group continued their normal technical trainings. The final test measurement protocol was applied after a full rest was provided at 48 hours intervals within 1 week after the training programs.

Tabata and Pliometric Training

In the training program, the subjects were divided into 3 groups. A training program was applied to each group 2 days a week for 6 weeks. Technique + Pliometric training for group A (first group); Training for group B (second group), Technique +Tabata; the technical training program was applied to the C group (third group). Tuck jump, Cossack jump, Pike jump and Straddle jump movements are used. Plyometric training was applied for 6 weeks. 5 movements were applied in the training. 1st and 2nd movement 4 sets; 3rd and 4th moves 6 sets; The 5th and 6th movements were performed in 8 sets. Each move is 10 seconds. Rest between movements is 1 minute. Rest between sets is 2-3 minutes. Tabata training was applied for 6 weeks. 5 movements were applied in the training. 1st and 2nd moves 2 sets; 3rd and 4th moves 3 sets; 5th and 6th movements were applied in 4 sets. Each move is 20 seconds. Rest between movements is 10 seconds. Rest between sets is 2 minutes.

Movements in Plyometric and Tabata Training

1. Jump Burpee Push Up
2. Half Squat Jump
3. Springboard Jump
4. Split Lunge Jump
5. Tuck Jump

Table 1. 6-Week Plyometric Training Program

Week	Movements	Movement time	Sets	Rest between movements	Rest between sets
1	1, 2, 3, 4, 5	10 s	4	1 min	2-3 min
2	1, 2, 3, 4, 5	10 s	4	1 min	2-3 min
3	1, 2, 3, 4, 5	10 s	6	1 min	2-3 min
4	1, 2, 3, 4, 5	10 s	6	1 min	2-3 min
5	1, 2, 3, 4, 5	10 s	8	1 min	2-3 min
6	1, 2, 3, 4, 5	10 s	8	1 min	2-3 min

Table 2. 6-Week Tabata Training Program

Week	Movements	Movement time	Sets	Rest between movements	Rest between sets
1	1, 2, 3, 4, 5	20 s	2	10 s	2 min
2	1, 2, 3, 4, 5	20 s	2	10 s	2 min
3	1, 2, 3, 4, 5	20 s	3	10 s	2 min
4	1, 2, 3, 4, 5	20 s	3	10 s	2 min
5	1, 2, 3, 4, 5	20 s	4	10 s	2 min
6	1, 2, 3, 4, 5	20 s	4	10 s	2 min

Statistical Analysis

SPSS 22 program was used. Shapiro Wilk Test was used for the distribution of normality in the evaluation of the data. In the analysis of normally distributed data, 2-way Analysis of Variance was used in 3 x 2 repeated measurements. Benforroni test was used to determine the source of the difference between groups. The confidence interval was chosen as 95% ($p < 0.005$) and values below were considered significant.

RESULTS

Table 1. Descriptive parameters of the subjects

Group (n=21)	**Pliometric**	**Tabata**	**Control**		
	Mean	Mean	Mean	Min-Max	Mean
Age (year)	12,93	12,85	12,89	12,00-14,00	12,85±0,18
Height (cm)	146	147	144	132,00-165,00	145,19±2,29
Weight (kg)	34	36	31	25,00-47,00	34,28±1,46
Sport Age (year)	7,14	7,42	6,85	5,00-9,00	7,14±0,241

Table 2. Comparison of pre-test and post-test parameters of the groups

	Pre-Test (X±ss)			Post-Test (X±ss)		
Parameters	Pliometric	Tabata	Control	Pliometric	Tabata	Control
CMJ (cm)	34,54±5,72	34,91±3,83	33,71±4,83	37,01±4,40	36,27±3,62	34,25±4,83
Skuat Jump (cm)	28,54±4,09	29,15±3,02	28,16±3,74	31,27±4,03	28,97±4,09	28,09±3,15
Bosco Number of Repetitions	68,85±3,57	72,00±3,21	65,14±7,28	59,57±3,57	60,14±3,21	63,14±7,28
Bosco Jump Heights (cm)	11,75±1,43	10,08±1,24	13,84±5,05	16,30±3,09	14,21±1,66	15,07±4,72
FEV1 (ml)	2,12±,51	1,47±,28	1,44±,50	2,23±,48	1,89±,33	1,65±,48
FVC (ml)	2,35±,40	2,06±,27	1,63±,50	2,33±,52	2,46±,30	1,98±,42
MVV (ml)	61,82±25,33	60,68±9,16	50,52±10,08	61,32±21,99	66,50±4,65	52,38±10,15
Tuck Jump (ms)	498,57±50,43	491,57±39,85	474,42±28,94	516,42±36,51	506,28±32,40	480,00±26,48
Cossack Jump (ms)	514,85±33,81	499,28±38,45	487,71±29,82	529,00±37,02	515,42±33,81	490,00±28,35
Pike Jump (ms)	510,57±32,17	502,57±38,10	500,14±34,66	534,28±29,04	511,71±36,01	502,71±35,78
Straddle Jump (ms)	543,00±36,16	541,28±25,66	533,00±30,40	565,14±30,98	550,71±26,62	533,00±35,31

The arithmatic average of the pre-test and post-test measurement values of each group of CMJ, Skuat Jump, Bosco Number of Repetitions, Bosco Jump Heights, FEV1, FVC, MVV, Tuck Jump, Cossack Jump, Pike Jump, and Straddle Jump measurements were given in the table 2.

Table 3. Comparison of groups in pre-test – post-test within groups, between groups and post-hoc

Within Group

	Time (Pre-Test- Post Test)					Time x Group				
Parameters	Sum of squares	sd	Mean of squares	F	p	Sum of squares	sd	Mean of squares	F	p
CMJ (cm)	22,262	1	22,262	10,01	<,005	6,46	2	3,23	1,452	<,26
Skuat Jump (cm)	7,091	1	7,091	1,593	<,223	19,127	2	9,563	2,148	<,146
Bosco Number of Repetitions	624,857	1	624,857	21,256	<,001	183	2	91,5	3,111	<,069
Bosco Jump Heights (cm)	114,626	1	114,626	9,581	<,006	22,9756	2	11,488	0,96	<,402
FEV1 (ml)	0,646	1	0,646	13,005	<,002	0,173	2	0,086	1,738	<,204
FVC (ml)	0,616	1	0,616	16,921	<,001	0,359	2	0,179	4,93	<,020
MVV (ml)	60,173	1	60,173	0,779	<,389	71,374	2	35,687	0,462	<,637
Tuck Jump (ms)	1697,357	1	1697,357	17,519	<,001	285,143	2	142,571	1,471	<,256
Cossack Jump (ms)	1237,714	1	1237,714	18,298	<,001	392,714	2	196,357	5,806	<,081
Pike Jump (ms)	1464,381	1	1464,381	18,641	<,001	819,619	2	409,81	5,217	<,016
Straddle Jump (ms)	1162,881	1	1162,881	10,827	<,004	864,333	2	432,167	4,024	<,036
p<0.05										

Between Groups

	Group					Error		
Parameters	Sum of squares	sd	Mean of squares	F	p	Sum of squares	sd	Mean of squares
CMJ (cm)	27,254	2	13,627	0,353	0,708	599,972	18	33,332
Skuat Jump (cm)	22,196	2	11,098	0,478	0,116	481,054	18	26,725
Bosco Number of Repetitions	33,476	2	16,738	0,694	0,512	434	18	24,111
Bosco Jump Heights (cm)	42,296	2	21,148	2,264	0,133	168,117	18	9,34
FEV1 (ml)	3,066	2	136,541	392,263	0,001	6,266	18	0,348
FVC (ml)	2,324	2	1,162	3,604	0,048	6,266	18	0,348
MVV (ml)	1185,176	2	592,588	1,476	0,255	7226,689	18	401,483
Tuck Jump (ms)	6823,619	2	3411,81	1,318	0,292	46588,286	18	2588,238
Cossack Jump (ms)	7692,048	2	3846,024	1,741	0,204	39763,857	18	2209,103
Pike Jump (ms)	3300,762	2	1650,381	4607,772	0,512	42730,571	18	2373,921
Straddle Jump (ms)	3164,714	2	1582,357	0,866	1,732	39763,857	18	1827,69
p<0.05								

Post-Hoc Comparisons

	Group 1 vs 2		Group 1 vs 3		Group 2 vs 3	
Parameters	Mean difference	p	Mean difference	p	Mean difference	p
CMJ (cm)	0,185	1,000	1,793	1,000	1,608	1,000
Skuat Jump (cm)	0,8447	1,000	1,7799	1,000	0,9352	1,000
Bosco Number of Repetitions	0,071	1,000	1,857	0,991	1,928	0,937
Bosco Jump Heights (cm)	1,8841	0,361	0,4252	1,000	2,3093	0,183
FEV1 (ml)	0,497	0,116	,627*	0,035	0,13	1,000
FVC (ml)	0,0832	1,000	0,5354	0,068	0,4521	0,148
MVV (ml)	10,119	0,594	2,024	1,000	12,143	0,379
Tuck Jump (ms)	8,571	1,000	30,285	0,398	21,714	0,821
Cossack Jump (ms)	14,5714	1,000	33,0714	0,237	18,5	0,934
Pike Jump (ms)	15,286	1,000	21	0,800	5,714	1,000
Straddle Jump (ms)	8,071	1,000	21,071	0,626	13	1,000
p<0.05						

In table 3, there is a statistically significant difference between the height averages of the pre-test and post-test active jump timing ($p<0.05$) regarding the active jumps, there is no statistically significant difference between the height averages of the pre-test and post-test jump timing for squat jumps. ($p>0.05$). There is a statistically significant difference between the pre-test and post-test regarding the number of repeats of the 30 sec Bosco test and the mean jump height ($p<0.05$). There is a statistically significant difference between the pre-test and post-test averages of FEV1 and FVC performances ($p<0.05$). When the MVV performances are examined, there is no statistically significant difference between the pre-test and post-test averages ($p>0.05$). There is a statistically significant difference between the pre-test and post-test averages of Tuck Jump, Cossack Jump, Pike Jump and Straddle Jump elements ($p<0.05$). In the Table 3, statistically significant difference in active jump timing height, squat jump timing height, Bosco repetition numbers, 30 sec Bosco average jump heights, MVV performances, flight times of Tuck Jump, Cossack, Pike Jump and Straddle Jump elements compared to exercise groups is absent ($p>0.05$). There is a statistically significant difference in FEV1 and FVC performances compared to the exercise groups ($p<0.05$). In addition, there is no statistically significant difference in the interaction between exercise groups and measurement times in active jump timing height, squat jump timing height, Bosco repetition numbers, 30 sec Bosco average jump heights, MVV performances, flight times of Tuck Jump and Cossack elements ($p>0.05$). There is a statistically significant difference in the interaction between FVC, Pike Jump and Straddle Jump ($p<0.05$).

DISCUSSION

The fact that there are few studies on aerobic gymnastics in the literature has led us to do this study. We compared the effects of plyometric and tabata methods on some performance and physiological values of aerobic gymnasts. At the literature, we see that there are many studies parallel to our study. Akyüz (3) compared the difference between different jumping methods and the duration of stay in the air in aerobic gymnastics athletes in his study. When looking at the comparison between jump methods in gymnasts, the average hovering flight values in active jump (525.86 ± 42.21 ms) and the hovering flight average values in squat jump (502.46 ± 32.98 ms) were found. He reported that there was no significant difference between the duration of the athletes staying in the air with different methods. Aleksandreviciene et al. (5) investigated aerobic fitness and physiological and energetic responses in aerobic gymnasts during the competition. The gymnasts demonstrated a progressive treadmill test and competition performances. Energetic response was calculated from oxygen uptake and blood lactate changes. They reported that the peak oxygen intake was higher in international competitors than in national competitors. During the competition, they concluded that the total energy and fractions of aerobic, anaerobic, lactic and anaerobic lactic energy, the contribution of anaerobic energy was higher ($p = 0.03$) in the international group. He reported that the aerobic condition of the athletes and the absolute energetic and physiological responses of the athletes during the competition were not different between groups of aerobic gymnasts with different performance levels, but the higher level of anaerobic energy was found in the group with higher performance levels. The high anaerobic energy capacity of aerobic gymnasts ensures that their competition performance is excellent. Church (9), the effect of warm-up and flexibility exercises on vertical jump performance was examined. They found that PNF flexibility studies had a negative effect on jumping. Harry (13) looked at the evaluation of the performance in vertical jump descent with maximum jump and found that the athletes who made fast landing after the jump showed higher vertical jump results than the athletes who made the slow descent. In the study, they reported that exercises with jumping over the body and fast descent support rapid ascent. Nagano (17) stated that in gymnastics, jumping characteristics of athletes are an important motor skill and jumping height is a determining factor in performance. It is stated that the vertical jumping ability of athletes, which is quite effective on performance, and lower extremity muscles are dependent on explosive power. Özmen (18) stated that non-professional gymnasts are partly organized with the stability of the trunk, dynamic balance and vertical jump height. Although there are various training methods including heavy resistance exercises, explosive strength exercises, electrostimulation exercise and vibration, they are used effectively for vertical jump performance. In the study, it was stated that most trainers and researchers agreed that plyometric training was a method of choice, while aiming to improve vertical

jumping ability and leg muscle strength. In our study, it was found that the highest increase was in the plyometric group with 9.56%, and it is similar to Özmen (18) study. In addition to the elements in aerobic gymnastics, which is one of the sub-disciplines of gymnastics, the use of the jumps in the transition and connections used during the competition, the grips on the landing and accordingly, the flexibility-containing transitions are made possible by the perfect use of the whole body. Athletes who lack biomotor skills suffer from serious loss of points by not being able to do some basic elements during the competition. It is seen that the technical tactics of the athletes who can reach the desired criteria in the branch are also strong. In a study by Kaldırımcı (15), it was stated that there was a significant improvement in the vertical jump performances of handball players as a result of the pliometric jump training with resistance training. In a study similar to this study, it was stated that handball athletes participating in the study also showed a significant improvement in one-foot vertical jump performance. In addition to these, it was determined that the noticeable increase in the levels of the handball players in the long jump with stopping was statistically significant. These findings obtained in our study support the study in which plymetric training in addition to resistance training in 15-17 age group handball players improved their jumping performance. Demirci et al. (10), in their study, divided male tennis players aged 16-18 into two groups of 10, and investigated the vertical jump effect by applying the tabata method 3 days a week for 6 weeks. As a result of the study, while there was no significant difference between the first group and the second group in the pre-test results, they found that there was a significant difference in the post-test results in the second group in which the tabata protocol was applied in addition to the studies. Bozdoğan et al. (8), in their study, regularly applied coordination and plyometric training to badminton athletes with an average age of 21.00 ± 1.00 years for 8 weeks. As a result of the study, they stated that plyometric and coordination studies had a significant increase on jumping ability and biomotor abilities. Anıl et al. (11) divided a total of 24 athletes consisting of 14-16 age group female basketball players into 2 groups of 12 people. They applied only technical training to the first group, and plyometric and technical training to the second group for 8 weeks, 3 training sessions a week. As a result of the study, it was stated that a significant increase was found in the pre-test and post-test in the plymetric + technical training group, while the athletes' body fat percentage decreased, performance was increased, and a significant increase was found in vertical and horizontal jump levels. Aykora (7) applied a pliometric training with the tabata program for 8 weeks to two groups of 64 female volleyball players between the ages of 16-18. While the normal training was applied to the first group, the second group was applied pliometric + normal training with the wearer method. As a result of the study, it was reported that while there was a significant difference between the pre-test and post-test in the study group, there was a significant improvement in vertical jump, long jump and dunk jump performances. İmamoğlu (14), as a result of the study of the effect of eight-week preparatory work on some biomotor and physiological characteristics of female football players, the body weight taken before and after the preparatory training, flexibility, 30 m, horizontal jump, vertical jump, anaerobic power, reaction time, the values of leg strength, thigh circumference and calf circumference were found to be statistically significant. Eight-week preparatory studies showed a decrease in body weight, reaction times, 30 m and circumference measurements, decrease in fat percentage and increase in jump values, leg strength and anaerobic power of football players. In the study, an eight-week training program was recommended for female soccer players in the developmental stage to be suitable for a high-level performance. In the study, while plyometric and tabata training provided significant improvements on the jumping performance of the athletes, it was determined that their averages did not differ statistically from exercise groups ($p > 0.05$). In the study, it was found that FEV1 and FVC showed statistically significant difference on respiratory function parameters ($p < 0.05$), while MVV did not differ statistically ($p > 0.05$). An effective jump in aerobic gymnastics is based on the athlete's motor characteristics (balance, power output, agility, jumping performance) and respiratory control. During training, the upper and lower extremity muscles and trunk of the gymnast directly or indirectly step in to stabilize the core muscles together with the diaphragm, resulting in an increase in respiration (4). During the use of the core, especially the abdominal respiratory muscles work actively. Aerobic gymnastics is an anaerobic branch. High-intensity repetitive activities during training or competition cause an increase in the ventilation of athletes. The increase in challenging vital capacity is affected by aerobic exercises, and

the increase in air flow velocity is affected by anaerobic-based activities (16). The reason for the changes in the forced vital capacity after the tabata protocol in the athletes participating in the study; It is thought to be a result of the intense use of repetitive movements of high intensity. On the C group basic elements (Tuck Jump, Cossack Jump, Pike Jump and Straddle Jump) used in aerobic gymnastics competitions, it was determined that their averages differed statistically according to the flight times ($p<0.05$). While the pliometric training group found more significant results on jumping performance compared to the other groups, the respiratory function parameters of the participants in the tabata group were found to be more significant. In aerobic gymnastics, group C jumping and jumping elements from the desired families are used more than other jumping and jumping elements. Therefore, in the aerobic gymnastics branch, the required technical or optional elements to be selected in the C group in the competition series will be at a technically perfect level, relaxing the athlete in terms of energy expenditure, and will increase the quality of the selected element. The ability of aerobic gymnasts to achieve this situation and to choose the alternatives of the elements in the elemental pool can be possible by improving and strengthening their jumping performance and increasing the time of stay in the air (flight time). Due to the high speed of the choreography or series times (1.20 ± 5 seconds) and the tempo of the music (150-160 Bpm) of the competitors, the energy expenditure of the athletes in an anaerobic environment is high. As a result, it is recommended to trainers to use pliometric training for jumping strength and performance increase, tabata training method to increase the continuity of the series, reduce energy expenditure and increase anaerobic capacity.

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