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Orignal article

# The effect of gymnastics training on anthropometric, somatotype and some performance characteristics in pre-school girls

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**Summary.** *Purpose:* The purpose of this study was to examine the effects of gymnastics training on some physical and performance characteristics in 6-7 age group pre-school girls. *Method:* In the study, height, body weight (BW), BMI (body mass index), BFP (body fat percentage), skinfold thickness (SFT), diameter measurement (DM), circumference measurement (CM), sitting height (SH), arm span (AS) and also for performance measurements vertical jump (VJ), standing long jump (SLJ) and flexibility tests were used as pre-test and post-test to the experimental group (EG) and control group (CG). The analysis of the data was evaluated in the SPSS 22 package program. The analyses related to inter-group, intra-group and the effect of training were made by multiple measures analysis of variance (MANOVA) in repeated measurements. Post Hoc comparisons in significant values were determined by Bonferroni Test. The significance level was accepted as 0,05. *Findings:* After 12 weeks of gymnastics training, it was seen statistically increase in height, SH and ASin favor of EG, statistically decrease in BFP value in EG, statistically increase in BW value in both groups, statistically increase in BMI value in CG. In addition, when the pre-test and post-test measurement results of the groups were examined, no significance in performance characteristics was found in CG, there was also statistically significant difference in all performance characteristics in EG. *Result:* It can be said that 12-week gymnastics training has a positive effect in terms of height, SH, AS, VJ, SLJ and flexibility in 6-7 age group girls.

**Key words:** Gymnastics, girls, anthropometry, motoric characteristics.

## Introduction

The relationship between body structure and exercise has been among the subjects that sports scientists have wondered in every period of history (1) and physiological parameters, performance measurements, body composition and physical profiles of athletes have been examined (2).

The anthropometry technique, which has been used for a long time in the field of Physical Education and Sports, includes somatometric measurements. In order to obtain these measurements, special positions and standard measurement techniques are used by selecting determined body points (3). Somatotype; it is the determination of muscularity, fatness and thinness (weakness) relationships by scientific methods, considering the external properties of the body composition. These classifications are named as endomorph, mesomorph and ectomorph. Heath Carter formulated the somatotype and subjected it to an assessment based on measurements (4).

As the records in sports are renewed with the help of advancing science and technology, the technical, technological, educational and economic standards of the countries they represent have become competitive (5). Today, in parallel with the developments in the

technological field, the possibilities of achieving more success in sports are examined through scientific studies. One of these sports is come up as gymnastics.

In recent years, a lot of research has been done on the anthropometric and motoric features of gymnastics. These studies are very useful for determining body sizes and condition in motor parameters of athletes in different ages. The selection of gymnasts, their forward programming and the more rational arrangement of the training plan depend on the results from such researches. Besides, these studies are also important in determining the structural and functional effects of gymnastics training (3).

Pre-school period is an important process which includes the critical age periods that the child should achieve the necessary gains to be a healthy individual. In this period, it is possible to make important advances in terms of cognitive, social, emotional and physical development by presenting intensive stimuli to the child. Giving motor stimuli to children in pre-school period significantly affects their motor, social and individual development (6).

The purpose of this study is to examine the effects of gymnastic training on anthropometric and some performance characteristics in 6-7 age group pre-school girls.

## Material and Method

16 girls with average age of 6 ± 1 year participated in this study voluntarily. Anthropometric measurements were obtained from the athletes in the sample group in accordance with the techniques suggested by the "International Biological Program" (IBP) (7) and "International Society for the Advancement of Kinanthropometry" (ISAK) (8).

BW, height, SFT (biceps, triceps, subscapula, suprailiac, calf) measurement, circumference (biceps, calf) measurement and diameter (elbow, knee) measurements were taken (Tamer, 2000). In our study, Heath-Carter somatotype determination method was used to determine the somatotype characteristics of the athletes (9). BFP of the subjects were calculated according to the Durnin-Womersley formula. According to this formula;

D = 1.1369 – 0.0598 x X
Log X = (Biceps + Triceps + Subscapular + Suprailliac)
VYY = (4.95/D – 4.5) x 100 (10).

While evaluating the motor performance data of the subjects, VJ, SLJ and flexibility (sit-stretch test) tests were used. Besides parental signed consent was obtained from parents of each player to participate in the study.

## Statistical Analysis

The analysis of the data was evaluated in the SPSS 22 package program. Pre and post-test distributions of variables according to groups were examined, normality of distributions and homogeneity of variances were determined by Mauchly'sSphericity Test and Levene test. The analyses of inter-group, intra-group and the effect of training were made by multiple measures analysis of variance (MANOVA) in repeated measurements. Post Hoc comparisons in significant values were determined by Bonferroni Test. The level of significance was accepted as 0,05.

## Findings

According to the descriptive statistics of the students participating in the study, average age of EG was 6.44 + 0.53 years, average age of CG was 6.25 + 0.46 years, average height of EG was 115.22 + 5.61 cm, average height of CG was 112.00 +6.26 cm, average BW of EG was 20.66 + 2.29 kg, average BW of CG was 21.48 + 4.39 kg, average BMI of EG was 15.57 + 1.44 kg / $cm^2$, average BMI of CG was17.02 + 26.02 kg / $cm^2$ (Table 1). In our study, it was understood that the somatotype value of EG was 2-2-3 and the somatotype value for CG was 2-2-4, and the ectomorphic value was dominant in both groups (Table 1).

In our study, as a result of the somatotype values calculated for EG (2-2-3) and CG (2-2-4), it was seen that both groups were in the balanced ectomorphic area (Figure 1).

According to Table 2, it was found statistically increase in height, SH and AS in favor of EG, statistically decrease in BFP value in EG, statistically increase

**Table 1.** Distribution of Descriptive Characteristics of Subjects

| Variables | n | Group | Mean | Sd |
|---|---|---|---|---|
| **Age (Year)** | 8 | EG | 6.44 | 0.53 |
| | 8 | CG | 6.25 | 0.46 |
| **Height (cm)** | 8 | EG | 115.22 | 5.61 |
| | 8 | CG | 112.00 | 6.26 |
| **BW (kg)** | 8 | EG | 20.66 | 2.29 |
| | 8 | CG | 21.48 | 4.39 |
| **Endomorph** | 8 | EG | 2.87 | 0.43 |
| | 8 | CG | 2.34 | 0.39 |
| **Mesomorph** | 8 | EG | 2.51 | 0.38 |
| | 8 | CG | 2.35 | 0.52 |
| **Ectomorph** | 8 | EG | 3.54 | 0.36 |
| | 8 | CG | 4.12 | 0.42 |

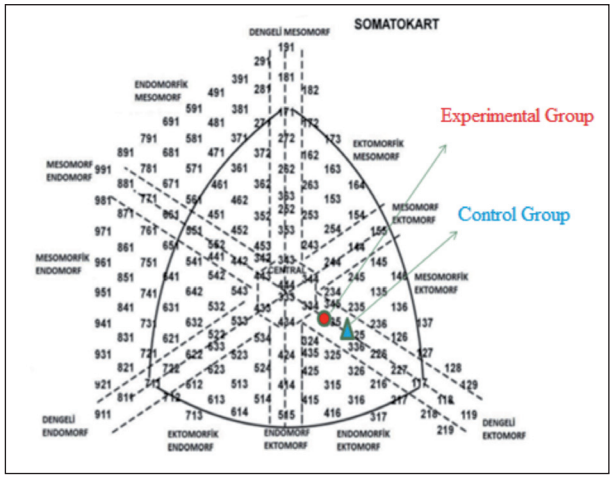


**Figure 1.** Place of the Participants in Somatochart

in BW value in both groups, statistically increase in BMI value in CG($p < 0.05$).

In Table 3, while Triceps SFT and Sub-scapula SFT values increased significantly in CG and these increases affected the test*group relationship ($p < 0.05$), there was no significant difference in any of the other measurements ($p > 0.05$).

According to the performance measurements in Table 4, it was found that there was a statistically significance in all parameters on behalf of EG ($p < 0.05$).

## Discussion

In the study, the physical and motor performance characteristics of 16 students, including EG (n = 8) and CG (n = 8) were evaluated. While EG participated in the 12-week gymnastics training program, the control group was not included in this program, and the physical, motoric performance characteristics of the subjects were compared intra-group and intergroupat the end of 12 weeks. In the discussion section of the study, firstly, evaluations will be made regarding the physical measurements of EG and CG, and then motoric performance characteristics.

In order to follow the physical development of the subjects and to have information about the physical structure, height-body weight measurements are made in almost all such studies. Today, BMI is widely used

**Table 2.** Examination of Physical Characteristics of Subjects

| Variables | n | Group | Pre-Test X ±Sd | Post-TestX±SS | Intra-Group Change (%) | Test*Group F | p |
|---|---|---|---|---|---|---|---|
| **Height (cm)** | 8 | **EG** | 115.22±5.61 | 116.06±5.51 | **0.84 (% 0.73)*** | **36.429** | **0.000*** |
| | 8 | **CG** | 112.50±5.24 | 112.63±5.24 | 0.13 (% 0.12) | | |
| **BW (kg)** | 8 | **EG** | 20.66±2.28 | **21.44±2.40** | **0.78 ( % 3.76)*** | **71.227** | **0.000*** |
| | 8 | **CG** | 21.48±4.39 | **22.26±4.39** | **0.78 (% 3.63)*** | | |
| **BMI (kg/m$^2$)** | 8 | **EG** | 15.57±1.44 | 15.53±1.35 | -0.04 ( % -0.26) | **6.121** | **0.026*** |
| | 8 | **CG** | 17.02±26.02 | 17.40±2.27 | **0.38 (% 2.23)** | | |
| **BFP (%)** | 8 | **EG** | 14.55±1.72 | 13.77±2.09 | **-0.78 (%5.36)*** | **5.215** | **0.037*** |
| | 8 | **CG** | 13.88±1.17 | 13.97+1.17 | 0.09 (%0.65) | | |
| **SH (cm)** | 8 | **EG** | 62.56±3.43 | 63.76±3.15 | **1.2 ( % 1.92)*** | **44.024** | **0.000*** |
| | 8 | **CG** | 63.62±3.54 | 63.66±3.52 | 0.04 (% 0.63) | | |
| **AS (cm)** | 8 | **EG** | 107.55±5.50 | 108.20±5.61 | **0.65 (% 0.60)*** | **27.182** | **0.000*** |
| | 8 | **CG** | 104.75±5.06 | 104.78±5.07 | 0.03 (% 003) | | |

* $p<0.05$

**Table 3.Examination of Anthropometric Characteristics of Subjects**

| Variables | n | Group | Pre-Test X ±Sd | Post-Test X±SS | Intra-Group Change (%) | Test*Group F | p |
|---|---|---|---|---|---|---|---|
| **TRICEPS SFT (mm)** | 8 | **EG** | 10.24±2.60 | 10.16±2.66 | -0.08( % -0,78) | **6.327** | **0.024*** |
| | 8 | **CG** | 9.45±1.53 | 9.63±1.53 | **0.18 (% 1,90)*** | | |
| **BıCEPSSFT (mm)** | 8 | **EG** | 7.33±2.06 | 7.31±2.06 | -0.02 ( % -0,27) | 0.194 | 0.666 |
| | 8 | **CG** | 8.38±3.98 | 8.45±4.04 | 0.07 (% 0,84) | | |
| **SUBSCAPULA SFT (mm)** | 8 | **EG** | 11.09±2.18 | 11.02±2.13 | -0.07 ( % 0,63) | **11.029** | **0.005*** |
| | 8 | **CG** | 10.42±2.84 | 10.53±2.79 | **0.11 (% 1,05)*** | | |
| **ILIAC SFT (mm)** | 8 | **EG** | 11.88±2.14 | 11.82±2.11 | -0.06 ( % -0,50) | 0.028 | 0.868 |
| | 8 | **CG** | 11.45±3.26 | 11.52±3.30 | 0.07 (% 0,61) | | |
| **CALFSFT (mm)** | **8** | **EG** | 9.15±2.70 | 9.11±2.54 | -0.04 ( % -0,44) | 3.468 | 0.082 |
| | **8** | **CG** | 8.15±1.84 | 8.25±1.83 | 0.10 ( % 1,22) | | |
| **BICEPS CIRCUMFERENCE (cm)** | 8 | **EG** | 16.77±0.97 | 17.11±1.05 | 0.34 ( % 2,02) | 2.263 | 0.153 |
| | 8 | **CG** | 17.37±2.06 | 17.43±2.01 | 0.06 (% 0,34) | | |
| **CALF CIRCUMFERENCE (cm)** | 8 | **EG** | 23.87±1.31 | 23.92±1.30 | 0.05 ( % 0,21) | 0.019 | 0.892 |
| | 8 | **CG** | 24.00±1.34 | 24.05±1.35 | 0.07 (% 0,84) | | |
| **ELBOW DIAMETER(cm)** | 8 | **EG** | 5.11±0.28 | 5.12±0.32 | 0.01 ( % 0,20) | 4.636 | 0.901 |
| | 8 | **CG** | 5.05±0.32 | 5.07±0.34 | 0.02 ( % 0,39) | | |
| **KNEE DIAMETER (cm)** | 8 | **EG** | 10.02±0.50 | 10.05±0.52 | 0.03 ( % 0,30) | 0.294 | 0.596 |
| | 8 | **CG** | 9.11±0.45 | 9.16±0.50 | 0.05 ( % 0,55) | | |

* p<0.05

to estimate obesity and body fat. In literature, there are studies supporting our study (11-14); there are also studies with differences (15-19) in terms of the descriptive statistics data of the students participating in the research.According to this, if the height is thought to be related to hereditary characteristics rather than environmental factors, and BWis thought to be related to environmental factors more than hereditary characteristics (20,21), the differences detected between our study and other studies result from heredity, age variable, environment of the subjects and socioeconomic level. In this study, the height value in EG made more progress compared to CG. There are many studies about the effects of sports on the development of children (especially on height and weight). Physical activities increase nitrogen retention and protein synthesis in the organism and, as a result, stimulate lateral growth (22). In addition, the BMI value in children is expected to increase with age, and the increase in CG supports this information, however, in this study, it can be said that the statistically significant height increase seen in EG led to a decrease in BMI value of children in this group. Regular physical exercises play a role in controlling hyperglycemia and obesity by burning excess calories and accumulated fat, as well as promote the elevation of basal metabolism resulting froman increase in lean body weight mass. Thus, resting energy expenditure also increases (23). So, it is thought that while the BFP level increases in sedentary people depending on age and immobility,there is a decrease in athletes according to the duration, type and frequency of the exercise.

In our study, the value of SH was determined as 63.76 + 3.15 cm in EG and 63.66 + 3.52 cm in CG. AS value was also determined as 108.20 + 5.61 cm in EG and 104.78 + 5.07 cm in CG. Kesilmiş(24) found SH value of girl gymnasts between the age 4-6 as 59.15 ± 3.90 cm and ASvalue as 106.08 ± 8.85 cm. It is thought that the difference in SH and AS values is due to the fact that the participants are in different age groups. It has been observed that medium intensity training programs affect the growth and development of children positively (25). In this study, the difference in development between the EG and CGas a result of training can be explainedby the positive effect of exercise on growth.

**Table 4.Examination of Performance Characteristics of Subjects**

| Variables | n | Group | Pre-Test X ±Sd | Post-Test X±SS | Intra-Group Change (%) | Test*Group F | p |
|---|---|---|---|---|---|---|---|
| **VJ (cm)** | 8 | **EG** | 16.66±3.96 | 19.22±4.11 | **2.56 ( % 15.36)*** | **55.803** | **0.000*** |
| | 8 | **CG** | 15.12±3.13 | 15.46±2.93 | 0.34 (% 2.24) | | |
| **SLJ (cm)** | 8 | **EG** | 93.38±8.57 | 99.33±7.80 | **5.95 ( % 6.37)*** | **24.995** | **0.000*** |
| | 8 | **CG** | 91.43±10.47 | 91.81±10.41 | 0.38 (% 0.41) | | |
| **Flexibility (cm)** | 8 | **EG** | 28.66±4.38 | 33.22±4.71 | **4.56 ( % 15.91)*** | **115.690** | **0.000*** |
| | 8 | **CG** | 26.06±2.28 | 26.43±2.32 | 0.37 (% 1.42) | | |

* p<0.05

*SFT Measurements*

In our study, the triceps SFT value was determined as 10.24 + 2.60mm in EG and 9.45 + 1.53mm in CG. In the literature, it was determined that the value found by Bektas et al. (26) was lower and the value found by Balci et al. (27) was higher than this study. In our study, biceps SFT value was found to be 7.33 + 2.06 mm in EG and 8.38 + 3.98mm in CG. While Ayan's (28) research supported this study, the value of Ziyagil et al's (29) was lower than our study. In this study, the subscapula SFT value was determined as 11.09 + 2.18mm in EG and 10.42 + 2.84mm in CG. In the study conducted by Kankal (14), it was observed that the value was lower, and the value found by Bektas et al. (26) was close to this study. In this research, iliac SFT value was determined as 11.88 + 2.14 mm in EG and 11.45 + 3.26 mm in CG. In the literature, Balci et al. (27) found lower value than our study. In this research, calf SFT value was determined as 9.15 + 2.70 mm in EG and 8.15 + 1.84mm in CG. It was found that the values of Bektas et al. (26) and Balci et al. (27) were higher than this study.

*Circumference Measurements*

The length, width and circumference ratios of body parts give information about the body's development and who will be more advantageous in sports branches. In this study, biceps circumferencevalue was determined as 16.77 + 0.97 cm in EG and 17.37 + 2.06 cm in CG besides, calf circumferencevalue was determined as 23.87 + 1.31 cm in EG and 24.00 + 1.34 cm in CG. The values of Ayan (28) and Pekel et al. (30) were found to be higher than this research.

*Diameter Measurements*

In this study, the knee diametervalue was determined as 10.02 + 0.50 cm in EG and 9.11 + 0.45 cm in CG besides, the elbow diameter value was determined as 5.11 + 0.28cm in EG and 5.05 + 0.32 cm in CG. In the study of Kalkavan et al. (31), while the values supported the elbow diameter results, the knee diameter results were lower than our study.

It was presented that the increase in the rate of fat was due to the insufficient physical activity and sedentary lifestyle, irregular eating habits, age and gender (32). According to this information, it is thought that the differences in anthropometric measurement values may have resulted from whether the subjects participate in sports or not, the type of sport performed, age difference and the content of the diet.

*Examination of Somatotype Values*

Somatotype is determined by anthropometric measurements and describes the morphological structure of a person. Somatotype profile is very important in determining the suitability of the individual to the sports branch. In this study, it was determined that the somatotype value for EG was 2-2-3, it was 2-2-4 for CG and the ectomorphic value was predominant. It was reported that the somatotype values of girls were endo-mesomorph in the study by Ayan(2006) and mesomorphic – endomorph by Balci et al. (27). It is thought that the differences in somatotype structures between this study and the literature are due to inheritance, nutrition, lifestyle, structural features of the athletes related to growth and development period and insufficient training depending upon the young age of athletes.

*Performance Tests*

Jump tests are used to measure the force feature indirectly, and in doing so, the jump height is used. In this study, the mean value of VJ of EG was determined as 19.22 + 4.11 cm and as 15.46 + 2.93 cm for CG. In the literature, the values of Turgut&Cetinkaya (33) were found higher than our study. SLJ is an anaerobic test for explosive force. In this study, the average of SLJ value was determined as 99.33 + 7.80 cm for EG and 91.81 + 10.41 cm for CG. The value of Muniroglu's (11) study was lower, and the values found by Pekel (18) and Aksit&Ozkol (34) were higher than this study. Flexibility is one of the most important aspects of physical fitness related to health and performance. It is defined as the maximum possible normal joint movement in a joint. In our study, the mean of flexibility test in EG was 33.22 + 4.71 cm and 26.43 + 2.32 cm for CG. In the research conducted by Bagci (35), while the average flexibility values of gymnasts were found higher than this study, the values of the sedentary group showedsimilarity. Besides, in the research of Mondal (36), values were found lower than this study.

In this research as a result of 12-week gymnastics training, it was determined that there were significant increases in all performance parameters in favor of EG. It is seen in literature that there are some studies presenting regular trainings affect the motoric performance and skills of children positively (37-39). In the light of this information, it is understood that 12-week gymnastics training provides positive improvement in the physical, anthropometric and selected performance characteristics of EG, there are also results that support our study in different studies in literature, on the other hand, it can be said that the differences in the researches that doesn't support our study result from the factors such as age difference, whether the subjects are athletes or not, environment, socio-economic structure and eating habits. The effect of regular exercise on the muscle and fat mass in many studies has been proven (40,41). It is known that the pressure effect on the epiphysis area of bones with an optimal duration and intensity causes growth-stimulating results on the contrary long-term vigorous exercises cause growth-inhibiting results (42).Thus, it is seen that countries that have achieved success in sports have given importance to the studies conducted in adolescence and preadolescent age in order todevelop the future athletes (43). As in all sports,especially physical fitness tests, talent detection should be done before and at the beginning of adolescence as well as in gymnastics. All these features must be measured and followed in order to identify and select the gymnasts at optimum age so that proper training models will be determined and time loss of the trainer will be prevented.Successful athletes who are directed to the appropriate sports branches will be trained for the future national and international competitions as a result of giving scientific sports training and following performance developments with scientific methods, considering the anthropometric and somatotype structures, psychological features of children.

**Conflict of Interest**

The authors report no conflict of interest.

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