# 57 - AN ANALYSIS OF THE EFFECTS OF PHYSICAL TRAINING ON YOUNG GYMNASTS`ANTHROPOMETRIC CHARACTERISTICS

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**INTRODUCTION**

Artistic gymnastics has been a present sport since the first Olympiad of the modern era, in Athens in the year of 1896, from that time it has evolved tremendously until becoming the sport that we see today. The competitions of feminine artistic gymnastics are held in four apparatus: Vaulting horse, parallel, beam and ground. The gymnast must obtain a high score in each apparatus to be successful in the general individual competition. For the team competition score, the four highest scores in each apparatus are considered.

Artistic gymnastics can be considered a complex sport. It includes a series of systematized exercises, nearly all the gymnast`s physical qualities are explored.

Among the qualities demanded in this sport, the physical characteristics seem to have an important role in its performance (Fernandes et al, 2005 and Prestes, 2006). Knowing the cineanthropometric and / or morphological factors might help in determining the physical characteristics of athletes who are already outstanding in the initial phases of their development (Venkataramana et al, 2004). Estimates of the body composition are widely used in the reach of the desired weight, optimization of the performance and to value the effects of training (Prestes et al, 2006; Silva et al, 2006).

Therefore, the objective of this study was to determine the effects of a 3-month physical training on young gymnasts`anthropometric characteristics.

**METHODS**

The sample was constituted by 09 gymnasts in the infantile category from Paraná state who had national level. They were all female, aged between 8 and 12, in the pre-pubertal stage. The maturational staging was used as the control variable, once the sexual maturation could alter the growth and physical characteristics parameters. Therefore, only girls in the pre-pubertal stage participated in this study. All of them have been involved in systematized training for at least four years.

The study respected all the instructions contained in the resolution 196/96 of the National Health Council for studies with human beings. It was approved by the National Ethic in Research Committee (CONEP), under the registration number 0008.0.301.000-07.

Pre and post-test of the anthropometric characteristics before and after the period of training were realized. This period was composed by a basic mesocycle of 3 months, characterized as basic preparatory special of development (Gomes, 2002). The training was composed of 1 daily session of training of 4 hours, 6 times a week. In the first 4 weeks of the training the physical preparation part was more intensified, and the gymnastics motor skills were kept stable. In the 4 following weeks, the training of physical preparation was kept stable and the acquisition of motor skills in the gymnastics movements was intensified. In the last month of of the training planned before the post-test the athletes entered in the pre-competitive period, new skills were introduced in the series, making them more complex. The physical preparation training remained stable. The microcycles can be better visualized in figure 1.

PICTURE 1- DESCRIPTION OF THE MICROCYCLES.

| | Month 1 | Month 2 | Month 3 |
|---|---|---|---|
| Week 1 | Ordinary | Control | Ordinary |
| Week 2 | Shock | Maintenance | Stabilizer |
| Week 3 | Ordinary | Maintenance | Pre-competitive |
| Week 4 | Shock | Maintenance | Pre-competitive |

Nomenclature of microcycles according to Gomes, 2002.

For the mensuration of the anthropometric variables, measures of body mass (Kg); stature (cm); body mass index - BMI (Kg/m2); triciptal, subscapular, suprailiac, medial thigh and calf cutaneous folds (mm); Contracted Arm, arm, forearm, medial thigh, calf, thorax, pelvis, abdominal, waist and hip circumferences (cm); wingspan (cm); lean body mass (kg); fat body mass (kg) were realized. The measures of body mass (Kg) and stature (cm) were realized in an anthropometric balance of the brand Filizola, personal model. For the measures of cutaneous folds, a Cescorf cutaneous folds compass was used. The measures of circumferences were realized with a tape measure of the brand Mabbis. The equation of Lohman (1992) was used for the calculation of the percentage of fat. Fat% = 0,546 ? subscapular, tricipital + 9,7 (for girls)

The fat body mass (Kg) was calculated through the following formula: Fat% x BM/100, where Fat% = percentage of fat and BM = total body mass. The lean body mass (Kg) was obtained by subtracting the fat body mass from the total body mass.

For the determination of the maturational stage, the date of the first menstruation was used. For bigger precision in the chronological age, the decimal age was determined. The reference was: The date of the collection of data and the date of birth of the individuals.

The data were expressed by descriptive analysis (mean and standard deviation) the signs in posts Wilcoxon test was used, with $p < 0,05$ to verify if there are differences in the anthropometric variables after a physical training program.

**RESULTS AND DISCUSSION**

The gymnasts selected for the present study belonged to the age group from 8 to 12 years old, Age was not a qualifying factor for this inquiry. The first menstruation was used as the control variable. Only girls categorized as pre-pubertal participated in this study.

In Figure 1, the descriptive analysis of the variables age (years), stature (cm), physical mass (Kg), Fat% and BMI can be observed.

FIGURE1 – CHARACTERIZATION OF THE SAMPLE IN THE PRE AND POST-TESTS.

| Variables | pré- teste (média, dp) | pós teste (média, dp) | p |
|---|---|---|---|
| Age | 10 ±2,83 | 10,4 ±2,83 | 1,00 |
| Stature(cm) | 130 ±4,24 | 130 ±4,24 | 0,71 |
| Body mass (Kg) | 26,8 ±4,74 | 28,4 ±4,67 | 0,00* |
| Fat% | 16,13 ±0,90 | 15,7 ±1,00 | 0,02* |
| Σ CF (trIciptal, subscapular) | 11±1,83 | 10,99±1,83 | 1,00 |
| BMI ( Kg/m²) | 15,64 ±0,82 | 16,06 ±0,86 | 0,01* |
| Fat body mass (kg) | 5,70 ±0,76 | 4,59 ±0,64 | 0,00* |
| Lean body mass (kg) | 21,10 ±1,96 | 23,78 ±2,31 | 0,00* |
| Wingspan (cm) | 132 ±6.13 | 134 ±6,06 | 0,00* |

*Value statiscally significant for Wilcoxon test ( p<0,05).

The mean stature was 130 cm in the pre and post-tests, with variability only in the standard deviation. These values are below the one recommended in the literature (Marcondes, 1982), which is 138cm for this age group. Stature is a determinant factor in the biotype of the athlete, and, depending on the stature certain sports will be easier for an athlete. In the artistic gymnastics the tracking process already selects the girls with low or medium stature due to the easiness that they will have while performing more complex movements com estatura baixa e média devido a facilidade que estas terão ao realizar movimentos mais complexos (Ferreira et al, 2006).

It is indicated in the literature (Viebig et al, 2006) that gymnasts normally present low stature compared to non-athlete girls. This fact can be justified by the training load / metabolic alteration relation, or by the detection of talents.

For Silva et al (2004) the high intensity of training causes a metabolic alteration that lifts the axle GH/IGF-I and raises the inflammatory markers. According to Ferreira et all (2006), IGF-I is an important reference to indicate the secretion of the growth hormone in children. Due to excess of training these hormones can be produced in low quantities, delaying growth and maturation, but with the suspension or reduction in the intensity of training the athletes retake their maturation and growth course normally. However, sometimes, the talents selection in the gymnastics itself already chooses athletes of lower stature, a strategy used for getting better results because of the mechanics of the movements.

In a study realized with gymnasts from Rio de Janeiro and Sao Paulo, mean age of 12, the athletes presented mean stature of 145,4 cm (Soares and Ribeiro, 2002). Comparing the results obtained in the present inquiry to those in Soares and Ribeiro (2002), the athletes in this study presented less stature. Nevertheless, the authors mentioned above did not control the maturational stage, and the age group of the athletes varied from 11 to 14 years old. Some variables that might be responsible for the low stature are: hereditary succession, intensive training, selection of athletes with this biotype, unsuitable diet and sexual maturation.

Another characteristic of the gymnasts in this study is the low body weight. The athletes presented mean value of 26,8±4,74 kg in the pre-test and 28,4 ±4,67kg in the post-test. Compared to the prescriptive values of Marcondes´s study (1982), the body weight for 10-year-old girls at this age should be 35,37 kg. Possibly, the gymnasts are below the ideal weight for their age. In the study by Soares and Ribeiro, (2002) the mean body mass of gymnasts from Rio de Janeiro and Sao Paulo was 38,5 kg. The low body weight presented by the sample in this study can be explained by the sexual maturation, since they were categorized as pre-pubertal.

Regarding the indexes Height for the Age (H/A) and Weight for the Height (W/H), according to the reference standard for adolescents in the National Center for Health Statistics (NCHS), all the athletes were between the percentiles 10 and 75, being classified as eutrophic (NCHS, 2000).

The body mass is an important factor in artistic gymnastics. Gymnasts with bigger fat body mass are slower and can have bigger risk of injuries, however the variable body mass (kg) is not the most used to determine if an athlete suits the adequate standards for her age and stature or not, sometimes, an elevated body mass is directly related to a biggest development of muscular mass, which would not mean that the athlete does not fit the standards,which was observed in this study. According to Claenssens et al, (1999) and Zetaruk (2000), the stature and elevated body weight have been considered a disadvantage for athletes who practice artistic gymnastics, it is a sport that demands agility, lightness and strength. The sport itself already makes its natural selection, managing to make those children with smaller body weight and lower stature outstand in it, since they can have bigger impulse and jump more lightly.

In the present inquiry, mean BMI was 15,54 kg/m2 in the pre-test and 16,06 ±0,86 kg/m2 in the post-test. Comparing these values to reference charts, the values were 17,02 kg/m2 (Must, 1991), and, 16,3 kg/m2 for the Brazilian population (Angels, Veiga and Castro, 1998). It is possible to affirm that our sample presents inferior BMI, plausibly because of the direct interference of training. Athletes present BMI lower than sedentary people´s. According to Soares (2003), Sato et al (2002) and Himes and Dietz (1994) the BMI is not a good indicative of fat body mass in children, due to the fact that this measure does not take into account the lean tissue. The quantity of body fat can be confused with the in-formations occurred in the lean tissue areas during childhood (Slaughter, 1988).

The percentage of fat was 16,13±0,90 % in the pre-test and 15,7 ±1,00 % in the post-test. Bemben et all (2004), realized an inquiry with gymnasts and found 18,1 %, for a group with mean age of 18,9; The variable sexual maturation was controlled and the group was composed by pre-pubertal girls, with menstrual dysfunctions and some of them were taking oral contraceptives.

Silva et al (n.d), num estudo realizado em Portugal com grupo de ginástica artística e rítmica, encontrou percentual de gordura igual a 16,1±4.38, valor semelhante ao encontrado na pesquisa em discussão. Num estudo realizado com 22 atletas de ginástica artística feminina (13,6 ± 1 anos) e 18 atletas de ginástica artística masculina (12,4 ± 1,6 anos), foi encontrado,e baixo percentual de gordura, e um aparecimento tardio da menarca (Weimann et al,2000).

According to Borgen and Oseid (1990), due to the great volume of training (physical and psychological), artistic gymnastics is a sport that demands reduced body mass, little fat mass and quite developed muscular mass for its participants to obtain success in it.

It was noticed that training increased the lean body mass significantly and reduced the quantity of fat. That can be observed by the increase in body mass and reduction in adiposity parameters such as: percentage of fat, BMI and fat mass.

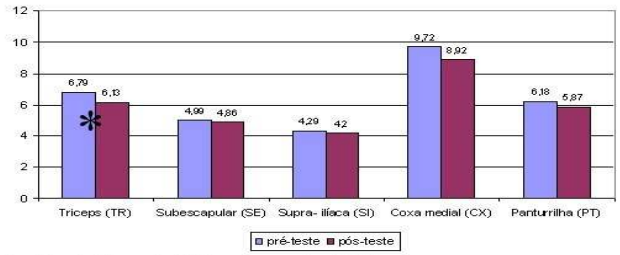
FIGURE 2 – VALUES OF SKIN FOLDS IN PRE AND POST- TESTS (mean, sd).

| Dobras Cutâneas (mm) | pre- test | post-test | p | Difference cm (%) |
|---|---|---|---|---|
| Triciptal (TR) | 6,79 ±1,29 | 6,13 ±2,30 | 0,01* | 0,66 (9,72) |
| Subscapular (SE) | 4,99 ±0,88 | 4,86 ±1,78 | 0,27 | 0,13 (2,61) |
| Supra- iliac (SI) | 4,29 ±0,84 | 4,2 ±1,51 | 0,63 | 0,09 (2,10) |
| Medial thigh (MT) | 9,72 ±1,59 | 8,92 ±3,09 | 0,17 | 0,8 (8,23) |
| Calf (C) | 6,18 ±1,26 | 5,87 ±3,08 | 0,10 | 0,31 (1,92) |

* Value statiscally significant for Wilcoxon test ( p<0,05).

There was a severe reduction of fat in all body segments (Figure 2), especially in the arm and thigh (significant result). In spite of the athletes being pre-pubertal, the biggest volume of fat is in the region of medial thigh.

GRAPHIC 1 – DESCRIPTION OF FAT DECREASE ACCORDING TO SKIN FOLD




* Value statiscally significant for Wilcoxon test ( p<0,05).

Graphics 1 and 2 show there was a bigger loss of fat in the medial thigh and triceps. What is explained by the bigger demand of exercises performed in the asymmetrical bars, which require strength and resistance from superior limbs while there is an elevated demand from inferior limbs on the ground, vaulting horse and beam.

Figures 3 and 4 present the values of circumferences in the pre and post-tests. Regarding the lateralization, it is noticed that the gymnasts present symmetry in superior and inferior limbs. There were increases of up to 0,5 cm, in superior and inferior limbs, which is explained by a possible increase in muscular mass, once there was a reduction in the quantity of fat (graphic 1) principally in the regions triciptal and thigh.

FIGURE 3 - CIRCUMFERENCES OF SUPERIOR AND INFERIOR LIMBS IN PRE AND POST-TEST.

| | Right | | | Left | | |
|---|---|---|---|---|---|---|
| | pre- test | post-test | p | pre- test | Post- test | p |
| Contracted arm | 21,2 ±1,30 | 21,54 ±1,05 | 0,05* | 21,17 ±1,07 | 21,41 ±1,14 | 0,02* |
| Arm | 19,49 ±1,12 | 19,72 ±1,08 | 0,37 | 19,21 ±1,19 | 19,49 ±1,29 | 0,09 |
| Forearm | 19,94 ±0,80 | 19,49 ±0,75 | 0,01* | 19,02 ±0,70 | 19,34 ±0,72 | 0,01* |
| Medial thigh | 37,08 ±1,70 | 37,99 ±1,62 | 0,01* | 37,03 ±1,83 | 37,9 ±1,65 | 0,01* |
| Calf | 26,21 ±1,26 | 26,83 ±1,15 | 0,01* | 26,12 ±1,18 | 26,84 ±0,99 | 0,00* |

* Value statiscally significant for Wilcoxon test ( p<0,05).

In a study carried out with athletes of rhythmical gymnastics from 11 to 18 years of age, Viebig et al (2006), found circumference of hip: 83,3 cm, thigh: 47,2 cm, arm: 22, 8 cm, waist: 63,3cm, abdominal: 70,6 cm and calf: 31,9 cm. The values are superior to those in the present study, probably because it was a different age group. Gymnasts from Rio de Janeiro and Sao Paulo (Soares e Ribeiro, 2002) presented the following values: thigh: 44,95; arm: 22,9; and calf: 29,45. Inferior values found in the present inquiry can be explained by the smaller quantity of body fat, or because of the incapability to have a hypertrophy due to little age, just 10 years old.

FIGURE 4 - CIRCUMFERENCES OF THORSO IN PRE AND POST-TEST.

| | pré- teste | pós-teste | p |
|---|---|---|---|
| Thorax | 67,37 ±3,32 | 68,98 ±1,11 | 0,04* |
| Thorax Inhauled | 69,89 ±3,35 | 73,01 ±2,78 | 0,24 |
| Thorax Exhauled | 66,28 ±3,07 | 68,86 ±1,54 | 0,07* |
| Abdominal | 56,39 ±4,46 | 56,7 ±3,62 | 0,76 |
| Pelvis | 63,29 ±4,46 | 65,84 ±3,62 | 0,00* |
| Waist | 54,11 ±2,70 | 55,01 ±2,83 | 0,23 |
| Hip | 63,2 ±2,71 | 65,79 ±2,24 | 0,01* |

* Value statiscally significant for Wilcoxon test ( p<0,05).

Concerning the trunk region (Figure 4), there was a substantial increase in the thorax circumference, explained by the increase of the cardio-respiratory capacity induced by training. It seems that the physical training alters the circumferences of contracted arm, forearm, thigh, calf, thorax, pelvis and hip.

**FINAL CONCERNS**

It was possible to observe a statistical difference between pre and post-tests for the following variables : body mass (kg), BMI (kg/m ²), fat body mass, lean body mass and wingspan. Regarding cutaneous folds, the most significant differences took place in the tricipital and medial thigh folds. In the circumferences of: contracted arm, forearm, medial thigh and calf, thorax, exhaled thorax, pelvis, hip.

Bigger reductions of fat and increase in lean body mass and circumferences in superior and inferior limbs can be explained by the great demand in exercises that use them. Gymnastics is a sport that demands great strength and power, it is necessary to have well-developed limbs to stand the training. The anthropometric alterations which result from a training program respect the specificity of the sport.

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**AN ANALYSIS OF THE EFFECTS OF PHYSICAL TRAINING ON YOUNG GYMNASTS`ANTHROPOMETRIC CHARACTERISTICS**

**ABSTRACT**

The objective of the present study was to analyze the possible alterations in young gymnasts` anthropometric characteristics. 11 pre-pubertal female gymnasts, aged between 8 and 12, were evaluated.

The anthropometric variables measured were: physical mass (Kg), stature (cm), BMI (Kg/m ²), lean body mass (kg), fat body mass (kg), circumferences (cm) and wingspan (cm).

The percentage of fat (%G) was obtained through the equation of Lohman.

In the statistics, the signs in posts Wilcoxon test was used, with p <0,05.

There was statistically significant difference in the variables: body mass, fat percentage, BMI, fat body mass, lean body mass, wingspan, triciptal cutaneous fold and circumferences of contracted arm, forearm, thigh, calf, thorax, pelvis and hip.

It has been concluded that the prescription of physical training alters substantially the components of adiposity and lean body mass, going in agreement with the specificity of the sport.

KEY WORDS: Artistic gymnastics, anthropometrics, physical training.

**L'ANALYSE DES EFFECTS DE L'ENTRAÎNEMENT PHYSIQUE SUR LES CARACTÉRISTIQUES ANTHROPOMÉTRIQUES DES JEUNES GYMNASTES**

**RESUME**

L'objectif de cette etude était analiser les changements possibles dans l'antropometric caractéristiques de jeune gymnastes. Il ont été évalués 11 pre-pubertaire féminin gymnastes entre les ages de 8 et 12 ans. Les anthropométriques variables mesurées étaient les suivantes: masse corporelle, l'IMC, hauteur, masse maigre, masse grasse, circunferences, et taille. Le pourcentage de grasse a été obtenue par l'équation de Lohman.

Dans les statistiques, il a été utiliser l'essai de signal en poste de Wilcoxon. Il avait statistiquement significative différence sur les variables: masse corporelle, pourcentage de grasse, masse maigre, masse grasse, l'IMC, circunferences, taille, pli cutané triciptal, et circunference d'avant-bras, bras contracté, jambe, cuisse, thorax, le bassin et la hanche. Nous avons conclu que la prescription de l'entraînement physique substantiellement changes le composantes de la masse maigre et adiposité, selon la nature spécifique du sport. MOT-CLE: Gymnastique artistique, anthropométrie, entraînement physique

**ANALISIS DE LA EFECTO DE LA ADIESTRAMENTO FISICO EM EL TEMA DE LA CARACTERISTICAS ANTROPOMETRIA DE JÓVENES GIMNASTAS**

**RESUMEN**

El propósito de la actual estudio estado analizar el posible alteraciones del características antropometría em jóvenes ginastas. Haber estado estimado gimnastas prepuberes de la sexo hembra, con edad entre 8 e 12 años. El variable antropomtría mensuradas haber estado: masa cuerpo (Kg), estatura (cm), IMC (Kg m²), masa delgado (kg), masa grasa (kg), circunferencias (cm) e aptitud (cm). EL porcentaje de grasa (%G) estado obtenido vía el ecuación de Lohman. En estadística, estado usado prueba del señales em postes de Wilcoxon, con p0,05. Él obtenía diferencia estatisticamente significación en el variable: masa cuerpo, % grasa, IMC, masa grasa, masa delgado, aptitud, ella rediles cutáneo triciptal e circunferencias de brazo contratado, antebrazo, muslo panturrilha, tórax, pelviano e anca. Síguese qué, el receta de adiestrando físico ella alterar sustancialmente componentes adiposidad e masa delgado, yendo según la específico de la deporte.

PALABRAS CLAVE: gimnasia artístico, antropometría , adiestrando físico.

**ANáLISE DO EFEITO DO TREINAMENTO FíSICO SOBRE AS CARACTERISTICAS ANTROPOMÉTRICAS DE JOVENS GINASTAS.**

**RESUMO**

O objetivo do presente estudo foi analisar as possíveis alterações das características antropomé tricas em jovens ginastas. Foram avaliadas 11 ginastas pré-púberes do sexo feminino, com idade entre 8 e 12 anos. As variáveis antropométricas mensuradas foram: massa corporal (Kg), estatura (cm), IMC (Kg/m²), massa magra (kg), massa gorda (kg), circunferências (cm) e envergadura (cm). O percentual de gordura (%G) foi obtido através da equação de Lohman. Na estatística, foi utilizado teste dos sinais em postos de Wilcoxon, com p<0,05. Houve diferença estatisticamente significativa nas variáveis: massa corporal, % gordura, IMC, massa gorda, massa magra, envergadura, dobra cutânea triciptal e circunferências de braço contraído, antebraço, coxa, panturrilha, tórax, pelve e quadril. Conclui-se que, a prescrição de treinamento físico altera substancialmente componentes de adiposidade e massa magra, indo de acordo com a especificidade do esporte.

PALAVRAS-CHAVE: ginástica artística, antropometria, treinamento físico.