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**EFFECT OF HOLISTIC GYMNASTICS IN THE FLEXIBILITY OF GIRLS BETWEEN 10 AND 12 YEARS****EFEITO DA GINÁSTICA HOLÍSTICA NA FLEXIBILIDADE DE MENINAS DE 10 A 12 ANOS**Fernanda dos Santos Lopes Niaradi<sup>1</sup> and Cecilia Guarnieri Batista<sup>1</sup><sup>1</sup>Universidade Estadual de Campinas, Campinas-SP, Brasil.**ABSTRACT**

The objective of the study was to evaluate the effect of Holistic Gymnastics on the flexibility of the lumbar and pelvic joints of girls aged 10 to 12 years. A total of 43 female children were divided into: 21 in the control group (CG) and 22 practitioners of Holistic Gymnastics in experimental group (EG), with 9 weeks of practice once a week. The flexibility was analyzed using photogrammetry (software SAPO) and the test on the distance the fingertip-to-floor (FTF) the ground (tape). Descriptive and inferential statistics were used with  $p < 0.05$  significance level. In fingertip-to-floor (FTF) test, in the comparison between the pre- and post-intervention measures, the average for CG increased by 2.9 cm, while the average for EG declined by 7.7 cm in finger-ground distance. For angle measures, the average for CG was 92° in pre intervention and 81, 8° in post intervention measure, with an increase in distance from the standard. For EG, the average was 86,8° in pre intervention measure and 92,4° in post intervention measure, indicating approximation to the standard. The comparison between groups showed a significant difference between them ( $p= 0.0001$ ). The Holistic Gymnastics produced increased flexibility.

**Keywords:** Movement. Range of motion articular. Flexibility. Physical therapy**RESUMO**

O objetivo do estudo foi avaliar o efeito da Ginástica Holística na flexibilidade da articulação lombar e pélvica de meninas entre 10 a 12 anos. Participaram 43 crianças do sexo feminino divididas em: 21 no grupo controle (GC) e 22 praticantes de Ginástica Holística no grupo experimental (GE), com 9 semanas de prática, uma vez por semana. A flexibilidade foi analisada através da fotogrametria (*software* SAPO) e pelo teste da distância do 3° dedo-solo (fita métrica). Utilizou-se estatística descritiva e inferencial com nível de significância de  $p < 0,05$ . No teste 3°dedo-solo, na comparação entre as medidas pré e pós- intervenção, a média para GC teve aumento de 2,9 cm, enquanto a média para GE teve redução de 7,7 cm na distância dedo-solo. Na medida do ângulo, a média para GC foi de 92° na medida pré-intervenção e de 81,8° na medida pós-intervenção, indicando um afastamento em relação ao padrão. Para GE, a média foi de 86,8° na medida pré-intervenção e de 92,4° na medida pós- intervenção, indicando aproximação em relação ao padrão. A comparação entre grupos mostrou diferença significativa entre os mesmos ( $p=0,0001$ ). A Ginástica Holística produziu aumento da flexibilidade das meninas de 10 a 12 anos.

**Palavras-chave:** Movimento. Amplitude de movimento articular. Flexibilidade. Modalidades de fisioterapia.**Introduction**

Flexibility can be defined as the passive mobility of a certain body segment, with limitation coming from this same structure. It is related to the extensibility of muscles, joint amplitude and plasticity of tendons and ligaments<sup>1</sup>. Partially determined by the genes, flexibility is a characteristic that presents differences in relation to gender<sup>2</sup>, promotes better movement efficiency, influences posture<sup>3</sup> and prevents musculoskeletal disorders such as low back pain or neck tension<sup>2</sup>. Flexibility tends to decrease throughout life. In addition to this general decrease predisposition, there are periods in which it is accentuated, such as, for example, between the ages of 10 and 13 years, by the disproportion in growth, in which the lower limbs become proportionally longer in relation to the upper body<sup>4</sup>. This reduction can be reversed, as demonstrated in a study carried out with adolescents, which reported that the practice of physical activity influences the increase of hip flexibility<sup>5</sup>. It has been reported that the conveniences of modern life have reduced the levels of children's physical activity<sup>6</sup>. The

World Health Organization recommends that children and adolescents should not exceed more than two hours daily in front of the TV screen, electronic games or computers<sup>7</sup>. It is worth remembering that children and adolescents already spend much of their time in school activities, which are generally performed in the seated position. Another factor that favors the sedentary lifestyle is the choice of leisure activities, in which physical inactivity prevails<sup>8</sup>. Therefore, it is plain to see that a sedentary lifestyle can aggravate the flexibility decrease.

Flexibility can be enhanced through different body practices and some stand out as: the Pilates method<sup>9-11</sup>, walking<sup>12</sup>, segmental stretching and global postural reeducation<sup>13</sup>, Yoga<sup>14</sup>, Ballet<sup>15</sup>, active, static stretching<sup>5</sup>, and methods of somatic education<sup>16,17</sup>. Taking in consideration the flexibility reduction in early adolescence and the contribution of the different practices mentioned above, it is important to emphasize the introduction of these practices in schools, in order to broaden their scope contribution.

In this study, Holistic Gymnastics (HG) is highlighted as a method of somatic education that plays an important role both in the prevention and in the treatment of the flexibility of children and adults. Activities are performed in each HG class with the aim of achieving relaxation, postural reeducation, respiratory balance, body awareness and stretching<sup>18</sup>. Relaxation and stretching are especially relevant for flexibility.

Relaxation in HG involves self-massage with auxiliary objects – such as balls, bamboo and wooden rods, seed cushions and foam rollers, stimulating the proprioceptive system – and specific movements performed at a slow pace. As for stretching in HG, the priority is that it is performed at the time of expiration, associated with the contraction of the perineum musculature, transverse abdomen and positioning the tongue on the palate. The muscle is elongated slowly, comfortably and painlessly, to the limit of the extent tolerated by the musculature.

The variety of movement in classes in intervention programs is important for learning motor skills, developing these skills in future situations, similarity with game situations, motivation of learners and the possibility of new educational conditions<sup>19</sup>. HG encompasses around 800 movements, adding motor skills and using a wide variety of materials, enabling a variety of classes<sup>18</sup>.

Therefore, we can see HG's contribution in fostering flexibility and prevention of pathologies. We can also stress the importance of making this practice accessible to the population in the mentioned age group. Thus, the objective of this study was to evaluate the effect of HG practice on the flexibility of students from public schools aged 10 to 12 years, focusing on the lumbar and pelvic articulations.

## Methods

### *Participants*

The participants were 43 girls, aged 10 to 12 years, 22 in the experimental group (EG) and 21 in the control group (CG) as shown in Table 1.

**Table 1.** Participants characteristics

Variable	Experimental Group		Control Group	
	Pre M ± SE	Post M ± SE	Pre M ± SE	Post M ± SE
Age (years)	10±0	10±0	11.14±0.79	11.33±0.91
Height (cm)	1.43±0.06	1.45±0.06	1.52±0.07	1.54±0.07
Weight (Kg)	40.23±11.50	41.84±11.41	42.91±9.63	47.28±19.11

Source: The authors

The inclusion criteria were: age between 10 and 12 years, female, healthy and signature of the Informed Consent Term (ICT). The exclusion criteria were: orthopedic, rheumatic or neurological disease sequelae, use of limb prosthesis and pain during the practice of physical activities.

The study was carried out in two cities in the same metropolitan region in the state of São Paulo (one city with approximately one million inhabitants and the other with approximately 200 thousand inhabitants), in five public schools (two municipal, three state).

Participants were chosen intentionally and for convenience. After the schools' consent to carry out the study, we invited all the students of the indicated age group. The researcher offered 09 classes of HG as an option, during the regular Physical Education schedule. We were informed that all participants from the 5 schools, in general, did not have access to extracurricular physical activity practices, and did not participate in school programs that could result in increased flexibility. Forty-seven students from two schools (1 and 2), who had infrastructure to carry out classes, were called and evaluated for the experimental group. Forty-two girls enrolled in three other schools (3,4,5) were evaluated for the control group. For the purposes of the analyzes presented in the present study, only the participants who attended all classes (schools 1 and 2) were considered for the experimental group. For the control group, we considered the participants who were evaluated and later re-evaluated (schools 3, 4, 5). As we sought to offer opportunities to include all the students of the age group considered and we had almost a full participation, we did not exclude any participant due to their level of flexibility.

### *Procedures*

A non-randomized controlled trial was performed. This study was approved by the Research Ethics Committee of the Faculty of Medical Sciences/UNICAMP, Campinas, SP, Brazil, under CAAE 0449.0.146.000-11.

### *Assessment of flexibility (before and after intervention)*

Flexibility assessment was carried out by the responsible researcher and involved all participants in the study. The girls were photographed in a left lateral view with their trunk leaning forward, knees extended, feet united, after localization and demarcation of the anatomical points proposed by the postural evaluation software – SAPO: <http://demotu.org/sapo/20>. This marking of the anatomical points was done with small Styrofoam balls wrapped with double-sided adhesive tape and placed in the specific points suggested by SAPO. This software is a reliable and accurate instrument to measure angles and distances<sup>21</sup> and has been used to measure flexibility<sup>22</sup>.

The "fingertip-to-floor" (FTF) test<sup>23,24</sup> is performed with the knees extended and the trunk flexed forward, aiming at the approximation of the fingertips to the floor, and it evaluates the flexibility of the lumbar spine and pelvis. This test was validated and considered reliable for both research (therapeutic trials) and clinical practice<sup>24</sup>. Flexibility was considered ideal when the participant touched her hand on the floor or when the distance between her 3<sup>rd</sup> finger to the floor was less than 10 cm. Participants with measures from 10 cm away from the 3<sup>rd</sup> to the floor were classified as having reduced flexibility<sup>22</sup>.

The flexibility assessment was performed through two measurement strategies: measuring the distance of the 3<sup>rd</sup> finger from the left hand to the floor in centimeters and measuring the angle between the femur trochanter, acromion and postero-superior iliac spine by SAPO software. The first measurement was made after the marking of the anatomical points. The other measurement involved the analysis of the photos.

The camera was positioned at a distance of 3 meters from the wall and was on top of a tripod with a height of 0.85cm. A plumb line was placed at a distance of 15 cm from the wall with two clothes pegs at a distance of 50 cm between them to allow the calibration of the photos. An Olympus FE-170/X-760 digital model and a DigiPod TR-157 tripod were used.

After the flexibility assessment, the 22 participants of the experimental group had nine HG classes. After completing the set of classes, a reassessment of flexibility was performed in all study participants (EG and CG), in the same way as the initial evaluation.

### *Intervention*

As for the dynamics of all classes, the first movement was done in the standing position, aiming to stimulate the lower limbs. Active relaxation was the goal of the exercise that followed, through movements or sensitization of the skin with the help of specific materials. Then, movements of postural reeducation and stretching. In the final part of the class, the participants made balance movements and more tonic movements, involving the lumbar spine flexibility. All movements are associated with breathing, usually performed at the time of exhalation. Figure 1 shows the dynamics of a GH class. Although the objectives were the same, the movements were performed with variations in each class,

Initial Position	Movement	Goal
1. Standing, parallel feet	Massage the sole with bamboo stick	Warming up
2. Dorsal decubitus, knees bent, feet on the floor	Rod on right paravertebral musculature. Perform arm and leg movements	Relaxation. Stretching
3. Dorsal decubitus, knees bent in the chest	Cervical and lumbar rotation.	Postural Reeducation
4. Sitting, knees bent and feet together	Movement of arms and legs, trunk rotation and inclination	Postural Reeducation
5. Sitting, parallel feet on the floor and hands on knees	Slowly lowering the trunk	Sit up
6. Dorsal decubitus and extended legs to the ceiling, with a ball between the feet.	Massaging the feet with the ball	Stretching
7. Standing, only the right foot on the ground	Balancing the body and creating movements with the whole body	Balance
8. Standing with parallel feet	Slowly flexing the trunk	Stretching of the muscles that form the posterior muscle chain

**Figure 1.** Movements performed in a HG class

Source: Authors

### *Description of two HG movements involving relaxation and stretching*

Movement 1. Initial position: Dorsal decubitus, knees flexed and feet resting on the floor.

Lie on top of a foam roll and relax the body on top of it.

- Breathe and relax the paravertebral musculature (*relaxation*).
- With the right arm extended, the palm of the hand facing the ground, drag the right arm on the ground until it reaches the height of the right shoulder and return to the initial position (*relaxation*).

- The right arm at the right shoulder height, turn the palm to the ceiling and drag the arm until reaching the right ear and return to the initial position (*relaxation and stretching*).
- Keep the right arm extended diagonally keeping it on the floor. Raise the right extended leg and keep the sole parallel to the ceiling, with the image "foot sole carrying crystals" (*stretching*).
- Right extended leg, dorsiflexed foot perform circles on the ceiling, with the image of "heel paint drawing circles on the ceiling" (*stretching*).  
Perform the movements with the left arm and leg.

Movement 2. Initial position: Left lateral decubitus, knees bent at hip height, place a foam ball between the two knees and position the arms in front of the chest with palms together.

- On exhaling, slide the right hand palm forward (*relaxation*).
- On exhaling, slide the right hand palm back (*relaxation*).
- Associate the two previous movements (*relaxation*).
- On exhaling, slide your right knee forward (*relaxation*).
- On exhaling, slide your right knee back (*relaxation*).
- Associate the two previous movements (*relaxation*).
- Raise the right arm to the ceiling and position it diagonally, flex the fist and make circles with the palm of the hand in both directions (*stretching*).
- Take the ball that lies between the knees, stretch the right leg forward towards the knee, back bending at the ankle and perform full-legged circle movement in both directions (*stretching*).

### *Statistical analysis*

We used the SAPO program (2005) <http://demotu.org/sapo/><sup>20</sup> to analyze data from the second measurement. The researcher calibrated the photograph reference to 150% of visualization and adopted the measurement of 50 cm between the markers on the plumb line.

We used the Kolmogorov-Smirnov test to evaluate the homogeneity between the samples from the EG and CG regarding the third finger and hip angle variables, since it is a non-parametric statistical test and evaluates whether two samples come from the same distribution resulting in consecutive p-values of 0.91 and 0.23. There is no evidence to reject the null hypothesis that the samples from the EG and CG of the third finger and hip angle measurements are homogeneous, at the significance level of 5%.

We performed a statistical analysis centered on numerical values using the following measurements: Mann-Whitney test (to compare the groups for the pre-intervention measurements) and ANOVA (for repeated measurements with transformation by stations) to analyze the effects of the intervention. The significance level of 0.05 was set for analysis. The statistical tests were performed in the SAS System for Windows Program (Statistical Analysis System), version 9.2.

## **Results**

Table 2 shows the results for the two flexibility measurements.

**Table 2.** Flexibility measurement obtained by the FTF (tape) and angle measurement (SAPO), for the experimental and control groups, pre and post intervention

Tests	Moments	Group	N	Mean	SE	P-value	
FTF test (fita) (cm)	Pre	Control	21	17.1	8.3	0.9031	
		Experimental	22	16.8	8.6		
	Post	Control	21	20.0	7.3		0.0001*
		Experimental	22	9.1	5.6		
Hip Angle Test	Pre	Control	21	92	7.2	0.0355	
		Experimental	22	86.8	8.2		
	Post	Control	21	81.8	7.4		0.0001*
		Experimental	22	92.4	5.1		

**Note:** \*significant for p-value lower than 0.05

**Source:** Authors

As far as the distance from the 3<sup>rd</sup> finger of the left hand to the floor in centimeters, the difference between groups for the pre-intervention measurement was considered non-significant ( $p = 0.9031$ ) indicating initial homogeneity between groups. When comparing the pre and post-intervention measurements, the mean for CG increased in 2.9 cm, while the EG decreased 7.7 cm in the mean FTF distance. The comparison between pre- and post-intervention measurements showed a significant difference between group and time interaction ( $p < 0.0001$ ). The analysis of the interaction between variables (group versus time) indicated a significant influence between groups ( $p < 0.0001$ ), leading us to attribute these changes to HG. Therefore, there was a significant reduction of the FTF distance in the EG.

Table 2 also presents the data on the girls' flexibility measurement obtained by the angle between the acromion, trochanter and posterior iliac spine made by SAPO (reference standard: approximately 90°). The difference between groups for the pre-intervention measurement was non-significant ( $p = 0.0355$ ), indicating that the groups were homogeneous. The comparison between the pre- and post-intervention measurements showed the CG with 92° in the pre-intervention measurement and 81.8° in the post-intervention measure, indicating a deviation from the standard. The EG mean was 86.8° and 92.4°, respectively, indicating a convergence to the standard. The comparison between groups showed a significant difference between them ( $p = 0.0001$ ), without interaction effects. Similar to the previous results of flexibility measurements, the data showed significant changes in EG, attributable to the intervention. Thus, the results are consonant, all of them noting an increase in flexibility for EG attributed to GH intervention.

## Discussion

The study results lead to discussions on different issues: measurement adopted, levels of flexibility before intervention, results of the intervention and its comparison with other studies, study limitations and necessity of further research, HG specific contributions and proposals for physical activity in schools.

With regard to the methodology for measuring flexibility, the literature emphasizes the sit-and-reach test and the FTF test<sup>3</sup>. The sit-and-reach test has a moderate validity in evaluating the flexibility of the hamstring muscles and low validity to analyze the flexibility of the spine muscle<sup>3</sup>. However, the FTF test assesses the mobility of the entire spine and pelvis and has proved to be reliable, in consonance with other studies<sup>3,13,22</sup>. We chose the FTF test because it evaluates the flexibility of the lumbar and pelvic articulations, the objective of our study.

Regarding the flexibility indexes, the participants of this study had a mean of 16.8cm, considered below the standard<sup>22</sup>. In a research carried out with children of the same age group

in Poland<sup>25</sup> the mean was - 6.27 cm. In another study<sup>10</sup> carried out in Spain with girls over 14, the mean was 2.81 cm. These data suggest a tendency of Brazilian children to present a reduction in flexibility when compared to European schoolchildren. We cannot explain this difference directly, but one possibility refers to opportunities for physical activity in different countries: everyday activities, sports and gymnastics in and out of school. The findings advocate an expansion of these assessments, in order to map this type of problem and suggest changes.

Our results indicated that, on average, the study participants had reduced flexibility of the lumbar and pelvic joints<sup>22</sup> before HG practice. After HG practice, the EG showed a significant increase in flexibility in the FTF and hip angle measurements, whereas a decrease in the flexibility was observed in the CG. Thus, it is possible to relate the EG results to the intervention program.

HG practice in the EG assisted in increasing flexibility in the lumbar and pelvic articulations. Before the intervention, participants had an average of 16.8 cm and, after HG practice, this average was 9.1 cm, a statistically significant difference. It is important to emphasize that there is a shortage of studies addressing the HG method in the literature. However, interventions that used other body practices obtained results of improved flexibility.

Czaprowski et al.<sup>25</sup>, in a study with the same age group (10 to 13 years), compared three physiotherapy techniques in relation to hamstring flexibility: 1) post-isometric relaxation, 2) static stretching combined with stabilization exercises and 3) stabilization exercises. These interventions were performed at a school, once a week, associated with daily exercises at home for a period of 6 weeks. The result of this study showed an increase in hamstring flexibility in the three groups studied and the mean flexibility of the groups was - 6.27 cm before the intervention and -3.73 cm after the intervention.

The Pilates method used by González-Galvez et al.<sup>10</sup> is another example analyzing the hamstring muscles flexibility in 14-year-old adolescents, with interventions twice a week for 6 weeks. In this study the girls' mean flexibility before the Pilates program was 4.62 (EG) and post-intervention 8.47 (EG). The post-intervention results of Czaprowski et al.<sup>25</sup> and González-Galvez et al.<sup>10</sup> presented better means than our study. However, it should be considered that European children had better flexibility indexes at pre-intervention time.

A study with adults using the Feldenkrais method<sup>16</sup> showed an increase in the hamstring muscles flexibility. This research presented a 7.04° gain in the participants' flexibility in the EG compared to 1.15° in the CG. We can consider characteristics similar to Feldenkrais and HG methods such as the stretching and balance of muscle tone, elements that may have favored an increase in flexibility. However, further studies involving somatic education methods that relate their characteristics to flexibility are necessary.

Zerbeto et al.<sup>26</sup> carried out a case study with a visually-impaired boy who presented reduced flexibility. HG improved flexibility at the post-intervention moment. The boy showed a 21 cm distance in the FTF test and after 8 sessions of HG practice, this distance decreased to 6 cm, a 15 cm improvement in the participant's flexibility. In the case study presented, the flexibility decrease is in agreement with the literature that highlights that 90% of the visually impaired did not attend physical education classes<sup>27</sup>, had few motor experiences and passive leisure<sup>28</sup>. Thus, it is believed that the HG practice assisted in the presented results.

Thus, it can be said there is a consensus in research on increased flexibility after different intervention programs.

This study was the first experimental research with the HG in schools. The limitations of this study were: difficulties in obtaining adequate space in the curricular period for the practical HG classes; commitment to obtain a minimum number of participants to take part in

the EG and CG; decrease in the number of students throughout the study due to the excess of absences of the participants during the school year.

We would suggest, for the next studies, an increase in the number of participants, so that the students' level of flexibility could be selected, both in the stratification of the sample and in the exclusion of participants with a high level of flexibility. In addition, a questionnaire containing the experience of each student with physical or sports activity practices performed in or out of school could improve the research regarding the association between flexibility and physical activity.

HG has been shown to be satisfactory in increasing flexibility and is likely to be due to relaxation and stretching. Relaxation assists the perception of bodily sensations and the balance of muscle tone while stretching preserves postural alignment and increases flexibility.

In this study, relaxation was an element present in all classes, which may have contributed to the practice of stretching movements, increasing participants' flexibility. Czaprowski et al.<sup>25</sup> with three different types of intervention, all successfully, increased flexibility and principles such as relaxation and stretching were present in the interventions. With our results, we can assume that relaxation may be an element that favors stretching movements and promotes an increase in flexibility.

As for stretching, Alencar and Matias<sup>29</sup> relate this element to an increase in flexibility, since these movements allow the increase in the number of sarcomeres and the stretching of the muscle, causing joint balance, postural adjustment and benefits in flexibility. In this study, stretching was present in all classes and may have contributed to the flexibility increase, since several studies related the first element as a consequence for the second. Coledan et al.<sup>5,30</sup> suggested that active static stretching provides an increase in the flexibility of schoolchildren, both at the time of warming up and at the end of the physical education class. Mayorga-Vega et al.<sup>31</sup> and Czaprowski et al.<sup>25</sup> concluded in their studies that stretching improved participants' flexibility. Since stretching is present in HG practice, in the Pilates method<sup>9-11</sup>, in GPR<sup>13</sup>, in Yoga<sup>14</sup>, in Ballet<sup>15</sup> and in the Feldenkrais method<sup>16</sup>, we can suggest that this is an indispensable element for increasing flexibility. However, each body practice uses stretching in a differentiated way and with specific characteristics.

As the reduction of flexibility is present in the growth and development phase, making the practice of daily activities and sports difficult and evolving into musculoskeletal pathologies<sup>1</sup>, it is important to diagnose it in this population and to suggest intervention programs. HG is a body-based global approach practice with important tools in both prevention and treatment of the schoolchildren flexibility. Moreover, its wide range of movements and materials can be a stimulating factor, particularly for children, promoting greater participation in the practical activities<sup>19</sup> and developing healthy habits in their routine. Further HG experimental clinical studies are necessary on the HG influence on flexibility. Since public schools are a universal environment for the studied age group, we would suggest further studies relating the flexibility of this population, since this physical ability in Brazil is reduced when compared to other countries.

## Conclusions

The intervention with the Holistic Gymnastics method increased the flexibility of girls aged between 10 and 12 years.

Since decreasing flexibility is a possible problem to be reversed, Holistic Gymnastics can be offered in order to promote healthy habits in the school population. Moreover, it can be practiced by students with reduced flexibility, in order to recover their appropriate conditions of flexibility, and also to prevent future problems.



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