ARTIGO ORIGINAL

RHYTHMIC GYMNASTICS ATHLETES POSTURE: ANALYSIS THROUGH PHOTOMETRY

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ABSTRACT

Posture is correlated with the sports modality and presents its own characteristics which the body has to adapt to and can cause postural disorders. Therefore, this study aimed to verify posture and its alterations in rhythmic gymnastics athletes using software called SAPO. It is a study that uses photometry – analysis of pictures captured of specific points marked on the athlete's body. 27 women aged between seven and 15 years, rhythmic gymnastics athletes from Maringá-PR participated in the study. Alterations were verified in all the athletes; however, some disorders being more remarkable, which can be justified by the characteristic aspects of the modality, and hence need to be further investigated. Thus, the evaluation of postural disorders becomes important to identify possible postural disorders.

Keywords: posture, photometry, evaluation, adolescent.

INTRODUCTION

Posture is defined as position or attitude of the body, that is, a balanced arrangement of the body structures for a specific activity, kept by the balance between musculature and skeleton, being determined by the positions of the segments between each other[1,2].

The correct posture is the position in which minimum stress is imposed on each joint, which for humans is the biped posture, in which the muscular activity to remain in this position is minimal. However, the posture alignment is determined by the situations of the musculoskeletal structures and their demands[3].

Posture alterations can be found both in sedentary individuals, due to their physical inactivity, and in physical activity practitioners, in a way they can alter and harm sports performance[4]. Cyclic and repetitive sports activities can trigger posture problems due to the automatization of gestures. Sports training is based on the constant repetition of some movements, which may lead to osteomyoarticular imbalance, causing changes in strength, flexibility, balance and motor coordination[5].

An example of these sports activities is rhythmic gymnastics (RG), which is an essentially feminine modality grounded on the artistic expression which requires high level of development of certain physical characteristics, with high performance demands, aiming technical perfection of complex movements performance with the body and apparatuses[6].

RG is a sport which requires high level of flexibility, coordination and balance. However, excessive increase of range of motion (ROM) of a joint, and consequently, the excessive strain of the surrounding soft tissues, may compromise articular stability and integrity[7].

It is necessary to early detect and prevent the alterations associated with recommendations about the correct posture, since the majority of the problems have idiopathic etiology and bad posture adopted in daily living[8].

In order to detect these alterations, is it necessary to perform a posture evaluation, which is an extremely important method used in physiotherapy, since from this point, posture is analyzed and the best can be done about the body use and future problems can also be avoided[9].

There are many methods of application of the posture evaluation, one of them being photometry, which uses a camera to take images of previously marked anatomic points which will be later transmitted to a computer for quantitative analysis of the found posture. For that purpose, specific software should be used to enable data more reliable than those obtained through classical evaluation only by observation, since the latter has shown low reproducibility[2,10,11].

The postural evaluation software (SAPO) is a computer program of quantitative posture analysis, developed by a multidisciplinary team, which respected issues of methodological and clinical nature[10]. It is a relatively simple and free program which provides besides linear measurements, angle values, distance and body angles measurements[12].

PURPOSE

Therefore, this investigation had the aim to verify posture and its alterations in rhythmic gymnastics athletes using the SAPO software, providing a more reliable and scientific evaluation.

METHODS

Study characterization

The present study was descriptive and transversal of exploratory and prospective character.

Sample

27 female subjects aged between seven and 15 years, RG athletes of a semiprofessional team of the city of Maringá, PR, the Maringá Gymnastics Association (AGIMAR) participated in the study.

The exclusion criteria for participation in the research were: refusal of the athletes and lack of presentation of the consent form signed by her parent or legal tutor.

Procedures

Initially, anamnesis was performed (name, age and time of training), followed by posture evaluation based on photometry by SAPO.

Posture analysis was performed in the training premises of the athletes (sports gymnasium of the Regina Mundi School of Maringá), in a large room with plenty of light, at the training time, through four photos of the individual at orthostatic position, with a Sony Cyber-shot camera, 5.1 *mega pixels*, on the following planes: frontal (anterior and posterior) and sagittal (right and left), which were taken after marking of the anatomic points with adhesive labels put on the athlete's body. On the anterior view, the marked points were (bilaterally): earlobe, acromion, anterosuperior iliac spine, femoral major trochanter, knee articular line, center of the patella, tibial tuberosity, lateral and medial malleolus. The posterior view covered the following points: T3 spine process and scapular inferior angle, calcaneus tendon, right and left calcaneus. Lateral views (right and left), used: earlobe, acromion, C7 spine process, anterosuperior iliac spine, posterosuperior iliac spine, femoral major trochanter, knee articular line, lateral malleolus.

The athletes were wearing shorts and a top and were positioned in orthostatism facing a simetrograph, and on an EVA mat (ethylene-vynil acetate) mat, rubber material which adapts to any environment, on which the athlete freely positioned for the first photo shooting, following the verbal command: "you will stand on this mat in a familiar and comfortable position and place your feet in the most comfortable position for you". Subsequently, the outline of both feet of the subject was drawn with chalk on the mat. After the photo was taken in a given view, the mat was rotated in 90° and the athlete positioned herself again on the drawing. This procedure was repeated for the four photos. The camera was positioned three meters away from the athlete on a tripod at the height of one meter.

After the photos were taken, they were transferred to the SAPO computer program where the points were analyzed and an individual postural report was designed.

Analysis through SAPO

In the anterior view, the following criteria were followed: head horizontal alignment (H.A.), acromial horizontal alignment (A.H.A.), anterosuperior iliac spines horizontal alignment (A.S.I.S.H.A.), angle between the two acromia and the two anterosuperior iliac spines (A.2A. 2E.A.S.), frontal angle of the right lower limb (F.A.R.L.L.), frontal angle of the left lower limb (F.A.L.L.L.), length difference of the lower limbs (L.D.L.L.), horizontal alignment of the tibial tuberosities (H.A.T.T.) and right and left Q angle (quadricipital) (R.Q.A.; L.Q.A.)[12].

On the posterior view, the analyzed criteria were: scapular horizontal asymmetry in relation to T3 (S.H.A. T3.), leg/right retrofoot angle (L.A.R.R.), and left retrofoot angle (L.A.L.R.)[12].

On the lateral views (right and left), the analyses occurred from: head horizontal alignment (C7) (H.H.A.), head vertical alignment – acromion (H.V.A.), trunk vertical alignment (T.V.A.), hip angle (H.A.), body vertical alignment (B.V.A.), pelvis horizontal alignment (P.H.A.), knee angle (K.A.) and ankle angle (A.A.)[12].

In order to analyze the data found,, the protocol determined by the SAPO program was followed, which states: positive values and counter-clockwise refer to posture swerve to the right and negative values and clockwise refer to posture swerve to the left.

Statistical analysis

Statistical analysis was performed through the *Statistica* program, version 7, and box plots of the found results were designed, which allow evaluate the data symmetry, their dispersion and the existence or absence of outliers in them.

Ethical considerations

The parents or legal tutors of all athletes signed a Free and Clarified Consent Form and the present investigation followed the Resolution 196/1996 of the National Health Board. The study was performed after approval of the Ethics in Research Committee Involving Humans of the INGÁ College of Maringá, PR under number 0180.0.362.000-09 and legal opinion 0180/09 from 06/11/09.

RESULTS

Sample characterization

27 female individuals, aged between seven and 15 years, mean of 10.4 years, participated in the study. The most prevalent age was from 10 to 12 years (45%), followed by seven to nine years (33%), representing an early beginning in gymnastics practice (figure 1).

Another criterion assessed was time of training (figure 1). Out of all athletes, 7.4% (n = 2) have been RG athletes for less than one month; 48.2% (n = 13) from 12 to 36 months; 29.6% (n = 8) from 48 to 72 months and 14.8% (n = 4) from 84 to 108 monyhs.

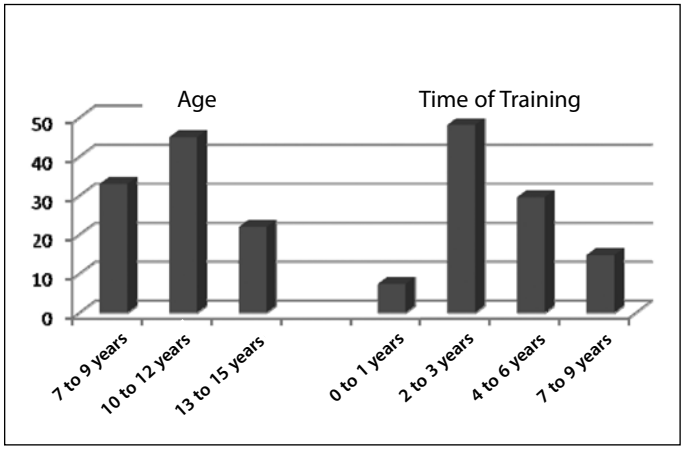

Figure 1. Number of athletes according to age and time of training.

Posture analysis

Data analysis enabled to identify some relevant aspects, such as mean, standard deviation (SD), median, minimum and maximum values, according to the views analyzed, namely: anterior, posterior, lateral (right and left) (table 1). Data suggest symmetry in all evaluated parameters.

The following figures presente the box plots of the analyzed measurements on the anterior (figure 2), posterior (figure 3), right and left lateral views (figure 4).

Criteria analysis revelas the presence of asymmetry. Many criteria were present with more elevation to the left (H.A., A.H.A., H.A.L.S.A.S., H.A.T.T.), while others revealed negative means, that is, wider distances to the right (A.2A.2E.A.S., F.A.R.L.L. and F.A.L.L.L.). The L.D.L.L. criterion reveals that, although the mean was close to the zero axis (considered normal), many outliers and extremes were

Table 1. Results of the posture assessment performed with the SAPO software.

	Tests/measures	Mean	SD	Median	Minimum	Maximum
Anterior	H.A	2.2	2.3	2.1	-1.7	7.2
	A.H.A	0.9	1.8	1.0	-3.4	3.6
	A.H.A.S.E.I	0.5	2.3	0.4	-4.3	5.5
	A.2A.2E.E.A.S	-0.6	3.2	-0.2	-5.5	5.5
	F.A.R.L.L.	-2.7	3.0	-2.8	-8.6	3.6
	F.A.L.L.L.	-1.7	3.4	-2.0	-6.8	5.5
	L.D.L.L	2.2	8.6	1.4	-11.6	22.5
	H.A.T.T	0.4	4.0	-0.8	-6.3	8.1
	R.H.A	16.8	7.8	16.1	2.8	31.6
	L.H.A	18.9	8.6	18.2	-0.3	33.6
Posterior	S.H.A T3	1.8	16.4	0.0	-32.7	33.8
	L.A.R.R	13.5	5.9	14.1	-4.8	23.9
	L.A.R.R	15.2	6.2	15.3	3.4	29.6
Lateral R	H.H.A	49.0	5.8	49.3	34.5	59.6
	H.V.A	17.1	7.1	16.6	1.7	30.2
	T.V.A	-5.5	2.5	-5.2	-10.0	-0.6
	H.A	-8.4	4.4	-7.7	-18.9	0.9
	H.V.A	0.2	2.0	0.2	-4.0	7.2
	P.H.A	-6.3	17.2	-9.8	-19.6	56.9
	K.A	2.1	5.9	2.0	-12.6	19.0
	A.A	85.0	3.9	84.7	76.9	97.1
Lateral L	H.H.A	43.9	5.6	43.7	34.8	56.6
	H.V.A	21.7	7.5	21.5	10.5	38.1
	T.V.A	-3.3	1.9	-3.9	-6.1	0.9
	H.A	-8.0	4.1	-8.5	-13.4	0.7
	H.V.A	1.8	1.3	2.1	-1.0	3.9
	P.H.A	-14.2	6.5	-14.0	-27.0	-3.0
	K.A	1.2	5.6	1.8	-12.8	10.8
	A.A	84.2	3.8	83.4	78.5	93.9

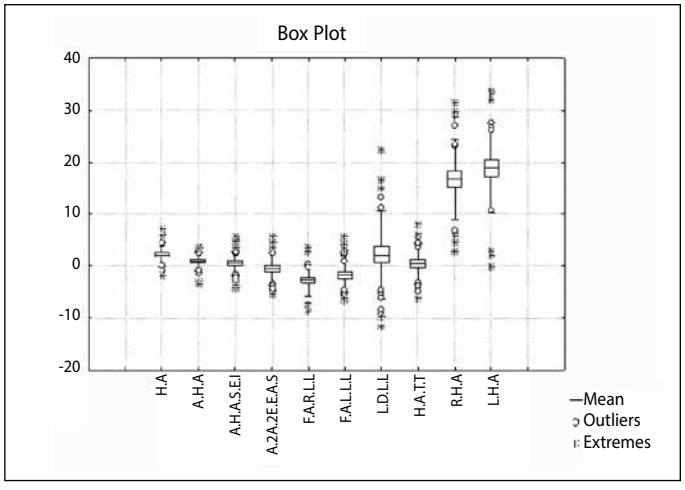

Figure 2. Box plot of the measurements on the anterior view.

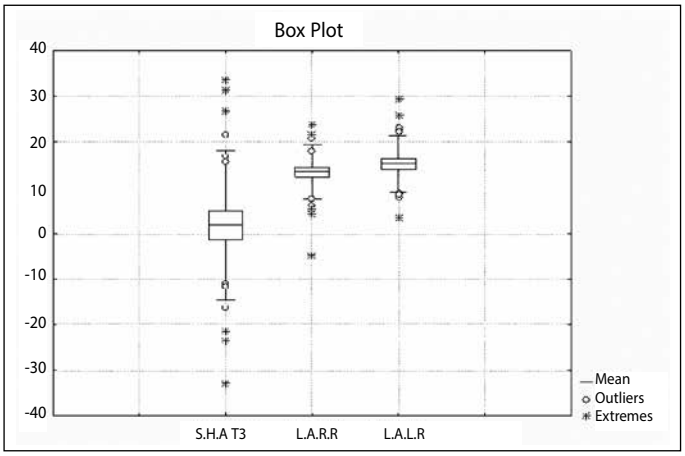

Figure 3. Box plot of the measurements on the posterior view.

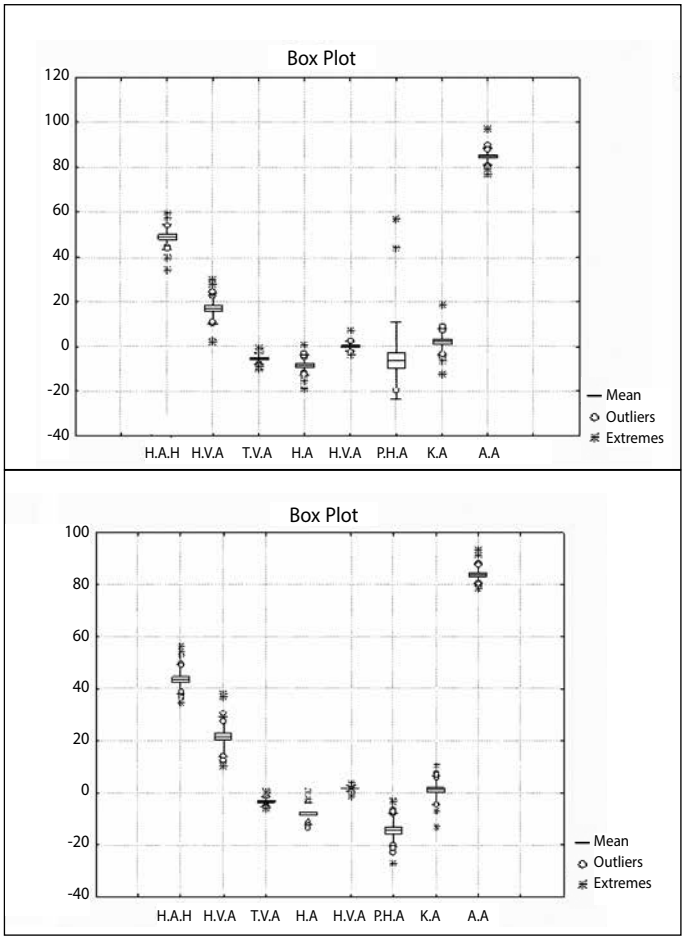

Figure 4. Box plot of the measurements on the right and left lateral view.

found, suggesting greater alterations, that is, greater differences of the right and left lower limbs. Concerning the H angle, the analysis revealed means around 16.8° and 18.9°.

Concerning the box plot of posterior view, the analysis of the scapula horizontal asymmetry criterion in relation to T3 (S.H.A.T3.) reveals mean close to normality; however, it demonstrates outliers and extremes. Additionally, the majority of the athletes present left scapula more elevated. The same fact occurs with the leg/retrofoot angle right (L.A.R.R.) and left criteria (L.A.L.R.), which revealed close means (between 12 and 18°), but some outliers and extremes are present, especially concerning L.A.R.R. (–4.8°).

The analysis of the lateral views reveals asymmetry concerning the criteria: trunk vertical alignment (T.V.A.), showing trunk more extended; hip angle (H.A.), suggesting hip extension; and pelvis horizontal alignment (P.H.A.), indicating pelvic retroversion. Head horizontal alignment (H.H.A.) indicates curvature of cervical spine and head vertical alignment (H.V.A.), protrusion of it. The ankle angle (A.A.), presented in figure 4, is totally distant from the other criteria; it is believed that the normal measurement for this angle is not zero, but 90°, which corroborates values close to normality.

DISCUSSION

Qualitative analysis has increasingly replaced the quantitative one concerning the postural study for physiotherapists. Some studies

have quantified posture through more evident bone structures, using a plumb line and/or simetrograph[13,14]. Over the years, greater concern with quantification of results and use of suitable instruments has occurred[15]. One of them is the SAPO program, a free program for postural evaluation which does not measure the spine column and does not aim to substitute examinations – X ray, but only aid in evaluation[12].

SAPO analyses posture, which is considered complex and dynamic. Therefore, massive discussion about the ideal approach for its quantification takes place, since it is conditioned to aspects of human life[16].

One of the main difficulties found in this investigation was to find reference values which enable the guidance of the results, especially concerning analysis of lateral view, besides scientific evidence, explanations about the method and its methodological strictness, since its use for posture evaluation is considered new in the field.

IN the present study, an early beginning in gymnastics practice is found. Akachi[17] reported that the beginning of sports practice has been increasingly earlier, which may generate postural alterations derived from early training, since children's bodies are under development and hence they are more prone to external overloads.

Another author suggests that increase in engagement and difficulty of the practiced exercises from excessively young age may be associated with increase and risk of alterations and injuries. The number of years of practice and the beginning of competition may be the main risk factors, since as the gymnasts improve their performance, the training time and intensity increase and consequently, the exposure time also increases and along with it the risk of alterations, asymmetry and injuries[18].

Additionally, posture presents correlation with the kind of sports activity practiced. Each modality is followed by a set of intrinsic characteristics which the body will have to adapt to, and which may influence on the onset of alteratins[19]. This statement may be corroborated in this study, since RG is a sport which requires high level of flexibility, coordination and balance. In its practice, specific acrobatic movements are performed and the body has to adapt to them. According to Achour Júnior[20], few athletes are able to acquire maximum flexibility with no harm to the surrounding tissues of the joints, besides body asymmetry due to musculoskeletal overload imposed by training and asymmetric movements performed.

Therefore, the results found by the present research with athletes on the anterior view, reveal that there is asymmetry in all criteria. The head horizontal alignment (H.A.) and difference in length of lower limbs (L.D.L.L.) criteria presented more remarkable asymmetry. These findings of alteration of lower limbs agree with Chockalingam et al. *apud* Baraúna[21], who, while studying, verified that alterations in pelvis and lower limbs kinematics are directly related to problems in the spine.

The difference of lower limbs may occur when the patient presents one side higher than the other. This asymmetry may also occur by muscular shortening, postural bad habits, inadequate visceral positioning, repetition and even scoliosis. The spine when front or back seen, should be straight, that is to say, alignment between the anatomic points of the right and left sides of the human body, a fact which was not found in this research[22].

When unilateral distribution of body weight is favored, a slight inclination of the pelvis may occur, promoting hence counterlateral compensation of the upper trunk, which can make the individual compensate the muscle and joint chains to reestablish his/her body positioning[3,23].

A study which describes and analyses the posture of students from the city education sector of Porto Alegre, RS, reports results similar to this research, that is, alterations concerning A.H.A and H.A.L.S.A.S.[24]. The same fact occurred in the study by Nery[25], with students from the city of Ribeirão Preto, SP, highlighting small symmetry found in the alignment between the two acromia and the two anterosuperior iliac spines (A.2A.2E.E.A.S.).

Conversely, another criterion assessed on the anterior view was the H angle, or quadriceps angle. It is known that the H angle provides some indication about the direction of lateral forces applied to the patellofemoral joint by the quadriceps muscle. Knees with increased H angle suffer increase of the lateral patellofemoral contact pressure during the flexion movement, and those with decrease of this angle suffer increase of the medial patellofemoral contact pressure in the same movement. Alterations in this angle may determine compression and sprains in the capsuloligamentar structures, lead to knee instability and development of arthrosis[26,27].

There is divergence concerning about the reference value for the H angle, and Magee[3] and Cabral and Monteiro[28], consider 13rd for men, and 18th and 13th for women, where the difference occurs due to the pelvis shape. According to Tribastone[29], the normal angle should be of 14th to 20th, regardless of gender. According to Sendur et al. and Mizuno et al.[26,27], the values of this angle range between 6 and 27th, with mean value of 15th, regardless of gender. Despite this important variation in the literature, the results of the present study revealed means which are according to the authors (16.8 and 18.9°).

Concerning the posterior view analysis, in the asymmetry found in the S.H.A.T3 criterion, Calais-Germain[30] stresses that the scapula is a bone able to move over the thorax in many directions: elevation, lowering, adduction, abduction, medial rotation, and lateral rotation. Thus, it can be observed that scapular movement is influenced by these possibilities of movement. The bone may get stuck to one of these positions due to muscular shortening, muscular bad habits, or even due to bone deformities, which may justify the outliners and extremes (important alterations) found by the present research.

Regarding the analysis of the leg/retrofoot angle criterion, both right (L.A.R.R.) and left (L.A.L.R.), which also presented asymmetry, it is recommended [3] that the ankle alignment evaluation is done first without body support and later with body support so that a more detailed observation of the ankle can be performed. In the analysis of these angles, it is observed that the found values were not considered reliable, neither the results by Iunes et al.[10], whose aim was to purpose a quantitative evaluation of the postural asymmetry and verify the intra ad inter examiner reliability as well as the method repeatability.

Finally, the postural evaluation on the lateral view may be considered more difficult, since it refers to angles intrinsic to the spine and its possible swerves, obtaining a more complex and dynamic approach which is able to be better explored in tridimensional evaluations[10].

Considering the lateral view, both right (R) and left (L), the athletes presented asymmetry, with special attention to alterations in the head horizontal alignment (HHA) and head vertical (HVA), besides difference in analysis for the ankle angle (A.A.). Nery[25] describes that the head alignment may be involved in the development of the lateral curvature of the spine, being observed during the installation of scoliosis, for instance. Kendall et al.[1] refer that the ideal head alignment is a balanced position with minimum effort of the neck musculature. The authors stress that the evaluation of head swerves is better observed on the lateral view, with the reference line agreeing with the earlobe.

Concerning the values found for analysis of the ankle angle criterion (A.A.), Nery[25], in his study found values similar to the ones in this study, with means of 86.3 and 88.7°.

CONCLUSION

Thus, according to the results found and according to the literature, RG practitioners or any other sports modality and even sedentary individuals may develop misalignment of the body structures and postural alterations, since the ideal posture is influenced by daily attitudes. This fact may be observed in the present study, especially in RG athletes. Plenty of asymmetry is verified, that is, postural alterations in all athletes. Some of the alterations are greater and need more specific further analyses.

Therefore, the instrument used for analysis, the SAPO program, was an interesting option for this kind of study, not only for being simple and free of cost, but also for being an useful and new instrument for the support of professionals in a more reliable, scientific and quantitative evaluation. However, since it is a new method for evaluation, further investigation in the field should be carried out for data acquisition and future comparisons between specific groups, making more specific analyses and more diverse possible.

Therefore, the postural evaluation of RG athletes was important as a prophylactic measure for identification of possible postural misalignment, in an attempt to guarantee better performance in sports technique and prevention of postural alterations which may occur.

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