ABSTRACT

Purpose. The purpose of this study was to assess the influence of hatha yoga exercises on the shaping of the antero-posterior spinal curvature in first-year students of the University of Physical Education in Katowice who participated in hatha yoga classes.

Methods. 72 women and 46 men took part in the study. Hatha yoga classes were held once a week for 90 minutes over a period of 15 weeks. Measurements of the subjects’ spines were performed twice, first before the start of the classes and then after all the classes were finished. The students were divided into three groups, the first composed of all the participants in the study, the second of students whom attended the yoga classes and practiced hatha yoga in their free time, whereas the third group was composed of students for whom hatha yoga was their only form of physical exercise. The inclination of the antero-posterior curvature of the spine, i.e. the thoracic kyphosis and lumbar lordosis angles, were measured with a Rippstein plurimeter.

Results. The results found that after 15 weeks of yoga, a decrease in the thoracic kyphosis angle (ThKA) and lumbar lordosis angle (LLA) occurred in most of the subjects. Differences between the values of these angles before/after yoga were statistically significant (p < 0.001), whereas in men, only a decrease of the thoracic kyphosis angle was statistically significant (p < 0.001). After completing the hatha yoga classes, the majority of students (50–62%) were found to have correct angular values of the thoracic kyphosis and lumbar lordosis when compared to the measurements taken before the start of classes (40–45%).

Conclusion. An assessment on the shaping of the anteroposterior curvature of the spine finds that hatha yoga exercises have a positive impact on one’s body posture in the sagittal plane.

Key words: physical recreation, hatha yoga, curvature of the spine, thoracic kyphosis, lumbar lordosis

Introduction

Body posture in the sagittal plane is very difficult to assess due to its permanent variability as well as due to a lack of precise evaluation standards. Body posture also depends on the physical and mental state of an individual as well as in their movement habits. However, proper body posture can be determined by the shaping of the anteroposterior curvature of the spine. It can also be used to measure the efficiency of one’s kinetic abilities, muscular balance and motor coordination [1].

If poor body posture is recognized, frequently in the case of children, corrective gymnastics are usually recommended for correction. However, maintaining correct body posture is a life-long effort as all spinal overloads caused by an improper body position can lead to serious ailments and chronic pain. Thus, regular physical activity composed of appropriate physical exercise which enhances core stability and articular mobility can help develop habits that maintain correct body posture.

Hatha yoga is, according to Polish standards, an official form of physical recreation. However, yoga is vastly different from conventional physical exercise, which itself is frequently composed of repetitive movements done at a certain rate with the whole or part of the body. Instead, hatha yoga is based on slowly assuming a particular body position (asana), holding it, relaxing the body and then slowly returning to the original body position. In attempting each asana, a yoga practitioner tries to achieve an optimal body position by placing specific body limbs both in relation to their body and to the ground through the use of their proprioceptors. Some authors also indicate that hatha yoga can be used as a corrective treatment for poor body posture [2]. Many yoga practitioners develop an ability to maintain correct body posture, increase their articular mobility and improve muscular strength and efficiency. There are many more benefits of practicing hatha yoga, one of which is that specific asanas can improve the functioning of the whole body, as well as its particular systems and organs [3–9].

Under the hypothesis that hatha yoga exercises improve body posture, especially in the sagittal plane, the aim of this study was to assess whether practicing hatha yoga did indeed develop habits of maintaining correct body posture in regards to the correct anteroposterior curvature of the spine. The study sample composed of first-year students at the Jerzy Kukuczka
University of Physical Education in Katowice, participating in obligatory hatha yoga classes as part of their PE curriculum.

**Material and methods**

The study sample consisted of 72 female and 46 male first-year students studying Sport and Tourism Management at the Jerzy Kukuczka University of Physical Education in Katowice. The subjects took part in obligatory hatha yoga classes once a week for 15 weeks. Two measurements of the subjects’ spines were carried out, first before the start of the classes and then after all the classes were finished. Students who missed more than one class during the 15-week period were excluded from the study.

The mean and standard deviation values of the participants’ ages (women: 19.8 ± 0.88 years; 19.7 ± 0.79 years) were similar, having a coefficient of variability at around 4%, which pointed to near sample homogeneity.

Some students (36% of women and 61% of men) also practiced other sports or forms of physical exercise apart from hatha yoga (with women practicing on average 2.4 times a week, men, 3.8 times a week). Of those involved in other forms of physical exercise, women most often practiced aerobics, swimming and volleyball; while men most often practiced football, strength sports, combat sports, cycling, volleyball and basketball. In addition, 18% of women and 11% of men declared practicing yoga exercises in their free time outside of the obligatory class, on average 1.6 times and 2 times a week, respectively.

With regard to the students’ participation in other sports or physical recreation activities the study sample was divided into three groups: Group I was composed of all students; Group II was of students who practiced no other forms of sports or physical recreation, but those who practiced hatha yoga in their free time; and Group III was of students who did not participate in any other form of physical exercise. For Group III, the 90-minute hatha yoga classes were their only form of physical exercise.

Measurements of the antero-posterior curvature of the spine were performed using a Rippstein plurimeter (Dr. Jules Rippstein, Switzerland). The thoracic kyphosis angle (ThKA) was measured with a zeroed meter at the seventh cervical vertebra (C7) and the upper part of the thoracic spine. The kyphosis angle was then measured by drawing a curve along the kyphosis to the top of the lumbar lordosis. Measurement of the lumbar lordosis angle (LLA) was done again with a zeroed meter placed at the lumbosacral and then drawing a curve along the lordosis to the top of the lumbar lordosis (Fig. 1). A value of 30° ± 5° was accepted for both angles as the correct spinal angle [10, 11].

**Results**

Measurements of the spine’s antero-posterior curvature before the start of the hatha yoga classes (Measurement I) found that the majority of students had incorrect body posture in their sagittal plane, with the remaining students having the correct thoracic kyphosis angle (ThKA) and lumbar lordosis angle (LLA) (Fig. 2, 3). The plurimeter measurements taken after completing the hatha yoga classes found improvement, with more than 50% of the subjects having the correct angles (Fig. 2, 3). The measurements therefore indicated a positive impact of hatha yoga classes on the improvement of body posture in the sagittal plane.

Analysis of both measurements of the antero-posterior spinal curvature angles show that in the majority of students the thoracic kyphosis angle (ThKA) and the lumbar lordosis angle (LLA) decreased after 15 weeks of hatha yoga classes (Tab. 1, 2). The differences in both angle values between the first and second measurements were statistically significant in all three groups of women; whereas in the groups of men only the thoracic kyphosis angle decreased significantly.

The study results found that hatha yoga had a beneficial effect on the reduction of the thoracic kyphosis angle, which offsets having a rounded back (kyphosis). Having the correct curvature of the thoracic spine in turn affects the correct positioning of the head and shoulder girdle, in expanding the chest, as well as it
having an effect on the correct shaping of lumbar lordosis. With regard to the examined subjects, this turned out to be highly desirable, as it was found that 31% of women and 37% of men in the study featured excessive thoracic kyphosis (at an angle of 40° and more). Moreover, excessive lordosis (at 40° or more) was observed more in women (22%) than in men (6.5%). Within the group of men, 33% had a more flattened lumbar lordosis, with an angle that was below 21°, thus for this group a further reduction of lumbar lordosis would not be advisable. The analysis found that hatha yoga’s influence on the flattening of the lumbar lordosis was statistically significant only in Group I ($p = 0.04$), whereas no significant differences were found in the other groups of men (Tab. 2). On the other hand, there was a statistically significant decrease in the lumbar lordosis angle in women. It should be emphasized that an excessive flattening of the lordosis usually leads to an overloading of the intervertebral joints and to pelvic anteversion, while a shallowing of the lordosis causes an overloading of the vertebral and intervertebral discs.

Table 1. Means and standard deviation ($\bar{x} \pm SD$) of the thoracic kyphosis angle (ThKA) of the first-year students at the Jerzy Kukuczka University of Physical Education in Katowice before beginning hatha yoga classes (Measurement I) and after their completion (Measurement II).

| Subject groups | Measurement I (ThKA) | Measurement II (ThKA) | t  | p    |
|----------------|----------------------|-----------------------|----|------|
|                | $\bar{x} \pm SD$     | $\bar{x} \pm SD$     |    |      |
| Group I        |                      |                       |    |      |
| women  $n = 72$| 34.65 ± 6.884        | 31.35 ± 5.771         | 5.44| 0.000001|
| men  $n = 46$  | 37.33 ± 7.743        | 32.02 ± 6.137         | 6.97| 0.000001|
| Group II       |                      |                       |    |      |
| women  $n = 46$| 34.57 ± 6.575        | 32.00 ± 5.914         | 3.38| 0.001488|
| men  $n = 18$  | 39.00 ± 8.623        | 32.00 ± 6.843         | 4.53| 0.000295|
| Group III      |                      |                       |    |      |
| women  $n = 36$| 34.86 ± 5.856        | 32.14 ± 5.617         | 2.93| 0.006089|
| men  $n = 14$  | 37.43 ± 6.903        | 31.64 ± 6.476         | 4.21| 0.001028|

Group I: all students; Group II: students who practiced no other forms of sports or physical exercise besides doing additional hatha yoga in their free time; Group III: students who did not participate in any other form of physical exercise excluding the hatha yoga classes

Table 2. Means and standard deviation ($\bar{x} \pm SD$) of the lumbar lordosis angle (LLA) of the first-year students at the Jerzy Kukuczka University of Physical Education in Katowice before beginning hatha yoga classes (Measurement I) and after their completion (Measurement II).

| Subject groups | Measurement I (LLA) | Measurement II (LLA) | t  | p    |
|----------------|--------------------|----------------------|----|------|
|                | $\bar{x} \pm SD$   | $\bar{x} \pm SD$    |    |      |
| Group I        |                    |                      |    |      |
| women  $n = 72$| 32.88 ± 6.838      | 30.65 ± 5.68         | 3.88| 0.000233|
| men  $n = 46$  | 26.57 ± 7.802      | 24.72 ± 4.246        | 2.15| 0.037373|
| Group II       |                    |                      |    |      |
| women  $n = 46$| 33.70 ± 6.514      | 31.41 ± 5.663        | 3.47| 0.001144|
| men  $n = 18$  | 26.17 ± 6.697      | 25.00 ± 4.887        | 1.1 | 0.288207|
| Group III      |                    |                      |    |      |
| women  $n = 36$| 33.64 ± 6.525      | 31.25 ± 5.684        | 3.04| 0.004424|
| men  $n = 14$  | 25.86 ± 6.479      | 25.00 ± 3.803        | 0.69| 0.502969|

Group I: all students; Group II: students who practiced no other forms of sports or physical exercise besides doing additional hatha yoga in their free time; Group III: students who did not participate in any other form of physical exercise excluding the hatha yoga classes
Discussion

Yoga makes the body more flexible, strengthens muscles and, above all, is conducive to spinal elongation and in maintaining correct body posture. Yoga practitioners consciously work with their bodies to properly align their body, so that the obtained yoga position becomes ever more stable and comfortable.

With those affected by a flattened antero-posterior curvature of the spine, as was found in many of the study's participants, hatha yoga would be beneficial as such exercises strengthen excessively extended muscles, e.g. thoracic spine extensors, and extend excessively contracted muscles, e.g. ischio-crural and pectoral muscles. However, one of the most important aspects of practicing yoga is postural re-education, i.e. the development and maintenance of correct body posture, which is often hindered by a number of improper postural habits.

The study results explicitly point to an improvement of body posture in the sagittal plane. Measurement of the antero-posterior curvature angles of the spine following the completion of the hatha yoga classes found that a greater percentage of subjects maintained correct body posture in the sagittal plane. This was manifested by a significant reduction of roundback, i.e. a decrease in the thoracic kyphosis angle, in all of the groups and in the group of women, a decrease in the lumbar lordosis angle.

The results of the present study correspond to those of Greendale et al. [12], who studied 118 men and women of age 60 and found a statistically significant reduction of hyperkyphosis (above 40°) in subjects attending yoga classes three times a week for 24 weeks when compared to a control group.

Yoga exercises are of particular significance in the development of correct body posture in children. They can be recommended as a component of PE classes or as separate remedial-compensatory classes. Šleboda [2] confirmed the therapeutic and educational value of relaxation and concentration exercises with integrated elements of hatha yoga as well as general kinesiology education, aimed at improving the body posture and agility of 8-year-old boys and girls. The beneficial effects of yoga on body posture were also noted in a study of fifteen 10-year-old children. After 6 months of practicing yoga, a significant correction was observed in shoulder and hip asymmetry, a reduction of head protrusion as well as the disappearance of such symptoms such as contracture of the pectoral muscles and back extensors [13]. All of these research results confirm the positive effects on hatha yoga on body posture, regardless of a subject's age and gender.

Performing each asana requires concentration and control of the body's position in order to avoid breaking the proper movements when entering a pose. Isometric contractions of the muscles enhance proprio-ceptive stimulation of the parts of the body that are involved, which in turn has a positive influence on their functioning. Stimulating such receptor can improve the functioning of the whole system, for example, through biofeedback. Furthermore, performing asanas can also release muscle tension, strengthen the ligamentous-capsular system and synovial tendon sheaths, as well as remove fascial restrictions [3]. Thus, hatha yoga can be effectively used not only as a corrective exercise, but in kinesiotherapy and as a form of preventive treatment [14].

Furthermore, analysis on the curvature of the spine in the sagittal plane of a basic hatha yoga pose (tadasana, the so-called Mountain Pose) in those who had been practicing yoga for a longer period of time found that this basic position elongates the spine, reduces flattening of the antero-posterior spinal curvature, expands the chest, improves proper head posture (in the so-called Frankfurt plane), prevents an unnatural retraction of the shoulder blades and is conducive to correct pelvic posture.

Nonetheless, proper body posture in the sagittal plane may depend on the time and frequency of regular hatha yoga exercise [9]. The present study did not examine the relationships between proper body posture and participation in additional sports or physical exercise due to significant differences in the identified study sample groups. In addition, it should be noted that the lowest number of differences between the angular values in the two measurements were found in Group III, comprising of students who did not participate in any other form of physical exercise. It should also be stressed that different forms of physical exercise or sports each feature different motor tasks. This particularly relates to those training competitively in sport, whose goal is to solely attain the best results in a sport and not maintain proper body posture.

In summary, body posture in the sagittal plane is an individual feature of every person and may depend on a variety of factors, above all, the type of physical exercise that is performed.

Conclusion

Before beginning their hatha yoga classes, about 40–45% of the subjects had correct angular values of the thoracic kyphosis and lumbar lordosis. After completing the 15-week hatha yoga classes about 50–62% of subjects were found with the correct spinal curvature angles. The study revealed a positive impact of hatha yoga on proper body posture in the sagittal plane. A significant decrease in the thoracic kyphosis angle was found in the studied male students. In the studied female students, both the thoracic kyphosis and lumbar lordosis angles were reduced.
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Correspondence address
Małgorzata Grabara
Katedra Turystyki i Rekreacji
Akademia Wychowania Fizycznego
ul. Mikołowska 72
40-065 Katowice, Poland
e-mail: Malgorzata@Grabara.pl