Body posture of young female basketball players

Małgorzata Grabara

Department of Recreation, Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

Summary

Study aim: To assess body posture and somatic parameters in young females practicing basketball in comparison with their non-training peers and to state whether there is a relationship between the quality of one’s posture and the length and frequency of training.

Material and methods: The study included 32 young female basketball players aged 13-15 years old. The period of basketball practice was 3-4 years for the group aged 13-14 years; the frequency of practice was 3-7 times per week. In the case of the group of 15-year-olds, it was 4-5 years, 4-7 times a week, respectively. The control group consisted of 37 young female subjects in the same age brackets that did not participate in any directed physical activity. Body height was measured with the use of a height meter at medical scales, whereas body mass, fat mass, and total body water mass were defined with the use of Tanita electronic scale. A specialist device using the projection Moiré method (MORA, CQElektronik System, Poland) was used to assess one’s body posture.

Results: Body height and water mass were significantly different in the younger group. However, the parameters of body posture differed significantly only in the group of 15-year-olds. The following have been observed: much greater asymmetries in pelvic placement in the transverse plane (p<0.05), significantly greater asymmetries of shoulder blades in relation to the transverse plane (p<0.01), as well as significantly smaller thoracic kyphosis angle (p<0.05) in female basketball players in comparison with the placement of the above parameters in their non-training peers. Moreover, correlations between the frequency of basketball practice and the deflection of the line of spinous processes, torso inclination angle, placement of shoulder blades in the transverse plane and towards the spine, kyphosis angle, and a synthetic index of body posture (i.e. postural symmetry) were noted.

Conclusions: Training basketball may lead to increased occurrence of asymmetry of one’s body posture.

Key words: Body posture – Asymmetries – Moiré technique – Young female athletes – Basketball

Introduction

Sport among children and adolescents is a very important stimulator for their development, both motor and physical. A good deal of studies emphasizes the positive influence of physical activity among children and adolescents in all aspects of health [7,12,15,16,19]. Participation in regular sports practice molds the character of a young person, improves one’s motor and coordination capabilities, and significantly affects one’s physical development and body posture.

Often, however, asymmetrical physical exercise unique to a particular sport may result in the occurrence of abnormal curvatures of the spine, particularly in the period of intensive growth. Some studies show that in many sports, especially those of asymmetric nature, disorders of the statics of the spine; trunk (i.e. torso) asymmetries; as well as disproportions of one’s muscle mass occur in the training subjects [4–6]. What is more, attention is paid to the influence of sports practice on the formation of antero-posterior curvatures of the spine [4,10,17,21]. Therefore, it is important to take special care of a young athlete, and to bear in mind that training programs should not only aim at the result, but should also foster the harmonious development of a young organism.

The purpose of the work is to evaluate body posture and somatic parameters of young females training basketball in comparison with their non-training peers, and to examine whether a relationship between the quality of one’s posture, the length of the training period (in years) and its frequency exists.

Material and Methods

The subjects of the study were 32 young females training basketball (experimental group E) aged 13-14 years (mean \(= 13.4 \pm 0.6\) years) and 15 years old (mean \(= 15.1 \pm 0.4\) years). The length of the period of basketball practice was 3-4 years for the group aged 13-14 years; the frequency of practice was 3-7 times per week. In the case of the group of 15-year-olds, it was 4-5 years, 4-7 times a week, respectively. The control group consisted of 37 young female subjects in the same age brackets that did not participate in any directed physical activity. Body height was measured with the use of a height meter at medical scales, whereas body mass, fat mass, and total body water mass were defined with the use of Tanita electronic scale. A specialist device using the projection Moiré method (MORA, CQElektronik System, Poland) was used to assess one’s body posture.

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practice for the group of 13-14-year-olds was 3-4 years, with the frequency of 3-7 times a week. For the group of 15-year-olds it was 4-5 years and 4-7 times a week, respectively. The data related to the length of the training period and its frequency was obtained from a questionnaire that was completed by the subjects’ parents. The control group (C) included 37 young females who did not undertake any guided physical activity, and who were in the same age brackets (mean = 13.3 ± 0.6 and 15.1 ± 0.4 years).

Body height (BH) was measured with the use of medical scales with a height rod (with 5 mm accuracy); body mass (BM), fat mass (FM) and total body water (TBW) were defined with the use of Tanita electronic scale (with 0.1 kg accuracy). On the basis of body height and mass, body mass index (BMI) was calculated.

A specialist device using the projection Moiré technique (MORA, CQEelektronik System, Poland) was applied to assess one’s posture [13]. Before recording, spinous processes (C7–S1), posterior superior iliac spines (M1, M2), and lower angles of shoulder blades (L1, L2) were marked on the subject. The subject was then placed with their back to the recording camera, and the record of the picture of one’s posture lasted for about 5 seconds. The short examination time allowed fatigue of postural muscles to be avoided, and at the same time the best record of the subject’s placement could be chosen.

In frontal and transverse planes, the analysis included the following:
- torso inclination angle (KNT), specified by the route of the C7-S1 straight line towards the perpendicular;
- deflection of the line of spinous processes towards the straight line C7-S1 (UK; mm);
- symmetry of the shoulders towards each other (KLB; mm);
- symmetry of the shoulder blades evaluated towards each other in the vertical direction (frontal plane) – the UL index, depth symmetry of the shoulder blades in the transverse plane – the UB index, and symmetry of the shoulder blades from the spine (closer-further from the line of spinous processes) – the OL index (mm);
- height symmetry (TT) and width symmetry (TS) of the waist triangles [mm], which are defined by a profile of the torso and the hip line;
- pelvic placement defined by the value of its inclination (frontal plane) – the KNM index, as well as torsion (transverse plane) – the KSM index (mm).

The values of all the above parameters were given as absolute values, obtaining zero deflections from the correct value regardless of the direction of these deflections (right-left, front-back).

In order to specify the total values of deflections from symmetry, a synthetic index of postural symmetry (WSyn) was introduced. The index reflected the placement of particular elements of the posture in the frontal plane and in the transverse one, by pointing deviations from their symmetry [3] (table 1). In the assessment of the placement of shoulder blades and waist triangles, a maximum of 3 points were given for an index with the greatest deflection from symmetry, without adding up the points for individual deflections.

Table 1. Criteria of granting points for the placement of particular elements of body posture for the synthetic index of postural symmetry (WSyn) [3]

| Variable | Number of points for the deflections mentioned below |
|----------|-----------------------------------------------------|
|          | < 1 | 1-2 | 2.01-3 | 3.01-5 | 5.01-10 | 10.01-15 | >15 |
| KNT      | 0   | 1   | 2       | 3       |          |          |     |
| UK       | 0   | 1   | 2       | 3       | 4       |          |     |
| KLB      | 0   | 1   | 2       | 3       |          |          |     |
| UL*      | 0   | 1   | 2       | 3       |          |          |     |
| UB*      | 0   | 1   | 2       | 3       |          |          |     |
| OL*      | 0   | 1   | 2       | 3       |          |          |     |
| TT**     | 0   | 1   | 2       | 3       |          |          |     |
| TS**     | 0   | 1   | 2       | 3       |          |          |     |
| KNM      | 0   | 1   | 2       | 3       |          |          |     |
| KSM      | 0   | 1   | 2       | 3       |          |          |     |
| KPT      | 0   | 1   | 2       | 3       |          |          |     |

Legend: KNT – Torso lateral inclination angle (°); UK – Maximum deflection of the spinous process C7-S1 (mm); KLB – Symmetry of the shoulders (mm); UL – Height symmetry of the shoulder blades (mm) UB – Depth symmetry of the shoulder blades in the transversal plane (mm); OL – Symmetry of the shoulder blades from the spine (mm); TT – Height symmetry of the waist triangles (mm); TS – Width symmetry of the waist triangles (mm); KNM – Pelvic lateral inclination in the frontal plane (mm); KSM – Pelvic torsion in the transversal plane (mm); KPT – Torso forward inclination angle (°); * , ** - Parameters for the placement of which there are maximum 3 points for the highest-assessed index.
In the sagittal plane, the following were taken into consideration:
- the route of the straight line C7-S1 in relation to the vertical axis, determining the torso lateral inclination angle (KPT),
- angular deflection from the perpendicular of the superior thoracic segment (α angle),
- angular deflection from the vertical of the thoracolumbar segment (β angle),
- angular deflection from the perpendicular of the lumbar-sacral segment (γ angle).

While assessing one’s posture, the asymmetry direction of the placement of particular parts of the body in female basketball players and non-training young females was analyzed on the basis of deflection values different from zero. Moreover, the percentage of young female athletes with deflections of the examined parameters above 10 mm for the placement of the pelvis, shoulders, and shoulder blades and above 5 mm for deflections of the lines of spinous processes (UK) was calculated.

The results obtained in the course of the computer examination of the posture and somatic parameters in female basketball players and non-training females were compared through t-test for independent samples. Pearson’s correlation between the length of the training period and its frequency with regard to the parameters of body posture was calculated. The Statistica software, version 9 (StatSoftInc, USA) was used for statistical analysis, the level of significance was set at $\alpha = 0.05$.

### Results

An analysis of somatic indices has shown significant differences of body height (BH) within the group of younger females (Table 2), which may be explained by the specificity of basketball, in which taller athletes can achieve better scores. Besides, in the same age group significantly greater values of total body water in the organism (TBW) were noticed. However, no considerable differences of somatic parameters in females aged 15 years were found.

The trunk (on the basis of the KNT index) was more often inclined to the left in both studied groups (69% basketball players and 70% non-training females). Deflection of the lines of spinous processes from the vertical axis was more often left-sided, both in basketball players (63%), and in the control group (73%), whereas in 22% of the basketball players and 24% of non-training subjects, a deflection value over 5 mm was stated. Deviations exceeding 10 mm were not noted. In total, 59% of basketball players and 70% of the non-training females had their pelvis inclined to the left (on the basis of the KNM index); however, no pelvic asymmetry in the frontal plane exceeding 10 mm was recorded. The majority of the subjects, i.e. 94% of the training females and 81% from the control group, were characterized by the left-sided pelvic torsion (on the basis of the KSM index). It was also noted that 50% of female basketball players were characterized by pelvic asymmetry in the transversal plane of a value exceeding 10 mm, while in the control group, asymmetry of this value was noticed only in 27% of the subjects. In the studied groups, 41% of basketball players and 51% of the non-training females had the left shoulder blade placed more inferiorly (on the basis of the UL index), and deflections greater than 10 mm were noted in 38% of basketball players and in 19% of the non-practicing females. The left shoulder was lowered as compared with the right one in 59% of female basketball players and in 62% of the non-training females, whereas in 16% of the training subjects and in 24% of the non-training ones, the asymmetry value exceeded 10 mm.

All the postural parameters that either define symmetry or the lack of it in the frontal and transverse planes, as well as the synthetic index of postural symmetry in the younger group, did not differentiate the training female subjects from the non-training ones. Within the group of 15-year-old females, considerably greater asymmetries in the pelvic placement in the transversal plane (KSM) and much greater asymmetries of shoulder blades in relation to the transverse plane were noticed, as compared to the arrangement of the aforementioned parameters in the non-training peers (Table 3).

### Table 2. Mean values (±SD) of anthropometric variables in young females practicing basketball (E) and in non-training females (C)

| Variable                  | Age group | 13-14-year-olds | 15-year-olds |
|---------------------------|-----------|-----------------|--------------|
|                           | E (n = 16) | C (n = 17)      | E (n = 16)   | C (n = 20) |
| Body height (cm)          | 164.8 ± 6.2 ** | 158.5 ± 6.8    | 166.0 ± 6.6  | 163.5 ± 6.7 |
| Body mass (kg)            | 54.7 ± 8.9 | 48.8 ± 8.0      | 56.0 ± 7.9   | 54.9 ± 8.2 |
| Body mass index (kg/m²)   | 20.1 ± 3.1 | 19.4 ± 2.6      | 20.2 ± 1.7   | 20.5 ± 2.6 |
| Fat mass (kg)             | 13.1 ± 5.9 | 10.5 ± 5.3      | 11.9 ± 4.4   | 12.6 ± 5.6 |
| Total body water (kg)     | 30.5 ± 3.0 * | 27.9 ± 3.3     | 32.3 ± 3.4   | 31.1 ± 3.2 |

Significantly different from the control group (C): * p<0.05; ** p<0.01
Table 3. Mean values (±SD) of postural indices in frontal and transverse planes in girls practicing basketball (E) and in non-training females (C)

| Variable | Age group | 13-14-year-olds | 15-year-olds |
|----------|-----------|-----------------|--------------|
|          | E (n = 16) | C (n = 17) | E (n = 16) | C (n = 20) |
| KNT      | 1.0 ± 0.7  | 1.2 ± 0.7  | 1.1 ± 0.9  | 1.2 ± 1.0  |
| UK       | 3.8 ± 2.3  | 3.6 ± 2.2  | 4.8 ± 2.7  | 3.5 ± 1.5  |
| KLB      | 6.8 ± 5.8  | 6.2 ± 5.2  | 7.4 ± 6.2  | 5.7 ± 5.8  |
| UL       | 8.0 ± 3.9  | 7.2 ± 4.3  | 8.3 ± 6.1  | 6.0 ± 4.4  |
| UB       | 15.3 ± 9.4 | 11.2 ± 7.1 | 16.2 ± 8.2 ** | 8.7 ± 7.1 |
| OL       | 5.2 ± 5.7  | 8.5 ± 5.1  | 8.2 ± 4.8  | 6.1 ± 4.6  |
| TT       | 11.7 ± 8.3 | 10.8 ± 10.0 | 11.7 ± 8.0 | 11.4 ± 7.2 |
| TS       | 10.7 ± 7.8 | 11.3 ± 6.1 | 9.0 ± 7.1  | 13.0 ± 7.8 |
| KNM      | 3.0 ± 2.0  | 1.9 ± 1.4  | 2.0 ± 2.0  | 1.8 ± 1.2  |
| KSM      | 10.1 ± 5.1 | 7.9 ± 5.1  | 11.2 ± 5.1* | 7.0 ± 4.8 |
| WSyn     | 10.0 ± 2.8 | 9.1 ± 2.8  | 11.6 ± 2.7 | 10.0 ± 2.8 |

Legend: KNT – Torso lateral inclination angle (º); UK – Maximum deflection of the spinous process C7-S1 (mm); KLB – Symmetry of the shoulders (mm); UL – Height symmetry of the shoulder blades in the transversal plane (mm); OL – Symmetry of the shoulder blades from the spine (mm); TT – Height symmetry of the waist triangles (mm); TS – Width symmetry of the waist triangles (mm); KMN – Pelvic lateral inclination in the frontal plane (mm); KSM – Pelvic torsion in the transversal plane (mm); WSyn – Synthetic index of postural symmetry (pts.); Significantly different from the control group (C): * p<0.05; ** p<0.01

Table 4. Mean values (±SD) of postural indices in the sagittal plane in girls practicing basketball (E) and in non-training females (C)

| Variable | Age group | 13-14-year-olds | 15-year-olds |
|----------|-----------|-----------------|--------------|
|          | E (n = 16) | C (n = 17) | E (n = 16) | C (n = 20) |
| α angle (º) | 14.4 ± 2.7 | 14.9 ± 5.0 | 12.4 ± 3.9 | 14.0 ± 3.8 |
| β angle (º) | 14.4 ± 2.3 | 13.8 ± 2.9 | 14.9 ± 2.4 | 16.1 ± 1.9 |
| γ angle (º) | 13.2 ± 5.4 | 13.9 ± 6.0 | 12.9 ± 7.1 | 15.2 ± 6.7 |
| Kyphosis (α+β) angle (º) | 28.8 ± 4.3 | 28.7 ± 6.6 | 27.2 ± 3.5* | 30.1 ± 4.2 |
| Lordosis (β+ γ) angle (º) | 27.6 ± 6.0 | 27.7 ± 6.8 | 27.8 ± 6.8 | 31.3 ± 6.7 |

Legend: KPT – Torso forward inclination angle (º); *Significantly (p<0.05) different from the control group;

The form of the spine and the placement of the torso in the sagittal plane within the younger group did not diversify the subject females. Only the thoracic kyphosis angle, defined by the sum of inclination angles of the superior thoracic segment and the thoracolumbar one, was significantly smaller in 15-year-old female basketball players (Table 4).

In order to check whether a potential connection between basketball practice and body posture exists, correlations between the training periods in years, the frequency of practice within a week, and postural indices were estimated. Only young females in training were taken into account in this analysis. The length of the training period had no relation with the quality of one’s posture. On the contrary, it has been noticed that there was a relationship (p<0.05) between the frequency of basketball practice during the week and the deflection of the lines of spinous processes (rUK = 0.427), torso lateral inclination angle (rKNT = 0.543), the placement of shoulder blades in the transversal plane (rUB = 0.468) or towards the spine (rOL = 0.412), inclination angle of the superior thoracic segment (rα = -0.461), kyphosis angle (rα+β = -0.405), and the synthetic index of postural symmetry (rWSyn = 0.550). On the basis of the calculations stated above, it may be stated that frequent basketball practice may lead to increased asymmetry of the posture, including an incorrect placement of the spine in the frontal plane. A correlation between basketball practice and one’s body posture in the sagittal plane was noticed in reference to the form of thoracic kyphosis (i.e. flattening, to be more precise).
Discussion

An analysis of somatic parameters did not confirm the facts of lower body mass and smaller percentage of adipose tissue in the female subjects in training, although increased physical activity fosters lesser adiposity [8]. On the other hand, significantly greater body height, as well as significantly greater total body water, has been proven in younger subjects training basketball.

An evaluation of body posture of the young females in training in comparison with their non-training peers only revealed considerable differences in the placement of the shoulder blades and the pelvis in 15-year-old females, and thus characterized by a longer training period and attending training more frequently. The study by Bussey [1] indicates that an asymmetrical placement of the pelvis, which is present in athletes, may be associated with a predominance of work of certain muscle groups responsible for the pelvic placement. However, the observed asymmetry of shoulder blades in the transverse plane may suggest an asymmetrical protrusion of one shoulder blade or a habitual trunk torsion, which results in one shoulder blade being closer than the other.

The observed correlations between postural indices and the frequency of trainings (0.405-0.550) indicate that there is a connection between basketball practice and one’s body posture, yet they concern other features of the posture than those significantly different in both compared groups. Studies of various authors [2–6, 9–11, 14, 17, 18, 20, 23] point out the influence of sports training on one’s body posture; however, depending on the nature of exercises specific for a particular sport, this influence may be both positive and negative.

Team sport games are characterized by both the symmetrical and asymmetrical work of the limbs. Thus, some asymmetrical elements (e.g. a throw to the basket from a layup in case of basketball), performed repeatedly during practice always only on one side, can perhaps lead to an effect of asymmetry of posture.

Zuchetto noticed in her study the occurrence of torso asymmetry in handball players, which she explained among other things by an asymmetrical work of the arms [23]. The study by Hawrylak et al. [6], based on the assessment of body posture with regard to its symmetry among university student-athletes, proved that asymmetries in the body occur quite often. The authors also noticed different placement of those asymmetries, which is related to the sport in question. In case of the subjects who trained for team sports, asymmetries over 10 mm were connected with the placement of waist triangles, whereas asymmetries of 5-10 mm were associated with the route of lines of spinous processes. In a comparative study of the posture of volleyball players versus non-training young females, substantially more frequent asymmetries of waist triangles and shoulders were observed in the subjects practicing volleyball [4]. Another study of the posture of female volleyball players mentions a typical posture with asymmetrical shoulder blades, shoulders, and pelvis [18]. Therefore, it follows from the cited studies that asymmetries of one’s body posture often appear among those who play team sport games, and that their placement appears to be different. If the values of these asymmetries exceeded 10 mm, one may talk about the deviations (or deflections) from the correct posture. For the sake of linear asymmetry indices (e.g. UK, OL, UL, TT), some authors assume 10 mm or greater deflections as considerable asymmetries, and 5-10 mm deflections as moderate asymmetries [20]. However, it is worth pointing out that not all of the parameters of one’s body posture influence postural quality to the same extent. Deflection of the line of spinous processes may upset one’s body equilibrium to a larger extent than asymmetrical placement of shoulders or shoulder blades. Although faulty postures associated with scoliosis, specified on the basis of 10 mm or greater deflections of the lines of spinous processes, were not noted in any subject groups, some vestigial side-to-side curves of the spine were found.

Studies of the posture among athletes [5] prove the existence of postural asymmetry. These studies point out that curved lines of spinous processes and an asymmetrical pelvic torsion occur in girls who train much more often than in their non-training peers. In case of runners, the authors explain this fact by the technique of running on a track along with greater strains of the spine during running [5]. On the other hand, a comparison between the posture of gymnasts and non-training females has demonstrated that asymmetries in gymnasts were smaller and occurred more rarely than in their peers, whereas in the sagittal plane, a greater increase of lumbar lordosis was observed in young females with a longer training period [2]. Other researchers drew similar conclusions, namely: the posture of young females doing gymnastics is more often correct than within the group of non-training subjects [14]. An assessment of the posture of young females practicing synchronized swimming and their non-training peers has shown that swimmers are much more frequently characterized by a symmetrical route of lines of spinous processes, shoulders and the pelvis, and their posture in the sagittal plane is more often described as of a very good or good type [11]. This leads to the conclusion that sport training has an impact on the form of the spine in the sagittal plane. It finds evidence in the findings of Wojtys et al. [21], who discovered an increase in thoracic kyphosis and lumbar lordosis in athletes doing
all sorts of sports. It needs to be noted that an inclination of anteroposterior curvatures of the spine varies in different sportspeople and often results from the specificity of a particular sport. It is also confirmed by the remarks of Lichota et al. [9]. In Mrozkowiak’s research [13], carried out with the participation of a large group of non-training children and adolescents who were examined from the point of view of their posture with the use of the same measurement technique as in their own study, average values of measurements of the angles of anteroposterior curvatures of the spine were lower than those recorded in the control group in this study.

On the basis of the aforementioned studies, it may be concluded that postural asymmetries also appear in children and the adolescents in training, especially among athletes who practice sports with elements of asymmetrical exercises.

Although postural asymmetry is a very common quality, and a symmetrical structure of the torso is very rare, one should not ignore the signs of an asymmetry of body posture. Often adopted poses of an asymmetrical nature may cause postural deviations, and in case of their consolidation, may lead to deformation [22]. Therefore, frequently performed physical exercises during training, which clearly emphasize the work of one side of the body, may influence the quality of posture.

Summing up, body posture in 13-14-year-old female basketball players and non-training females did not differ significantly. In the group of 15-year-olds who were training basketball, the placement of the shoulder blades and pelvis in the transverse plane was characterized by greater asymmetry, and the angle of thoracic kyphosis had significantly lower value than in the group of their peers. The length of the training period did not show a relationship with the quality of posture. However, it has been stated that more frequent participation in basketball training may contribute to an increase in the asymmetry of shoulder blades, have a negative effect on the placement of the spine in the frontal plane and on the torso inclination angle, and may lead to a decrease in the angle of thoracic kyphosis. On the basis of this study, it cannot be explicitly stated that basketball practice fosters symmetrization.

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