Original Research Article

Screening for asymmetries in upright posture using the posture screen mobile application in adolescence: Potential factors of postural disorder and asymmetries

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The upright posture is determined from the spine, the chest, the position of the head, the angle of tilting of the pelvis and the state of the limbs. Standing up is a habit, which is learnt during childhood and adolescence in relation to the way of life. The way children stand is monitored using the Posture Screen Mobile (PSM) application. The purpose of the present research was to investigate the asymmetries of the upright posture from the anterior, posterior, right and left lateral sides in adolescence, using the PSM application. Our study included 30 children, boys, aged 13 to 16 years who participated in football academy sessions, three times per week with a one hour duration of training. Without recent injuries, chronic disease and musculoskeletal problems may be the cause of asymmetry of the body. The sample selection was non-randomized. The results of the study indicated that there are often factors that lead to the adoption of a faulty body posture, 16 children (53.3%) held bags that exceeded 10% of their body weight. Sixteen (16) children (53.3%) held a backpack exclusively on one shoulder. A total of 23 children (76.7%) adopted the wrong seated position during study. We observed the results of using the Posture screen Mobile(PSM) that there are differences in translations and the angulation was some few centimeters but not statistically significant(p>0.05). In the anterior position, half of the children had translations below 0.02cm and 0.04cm in the posterior position.

Keywords: Posture Screen Mobile (PSM), upright posture, systematic exercise of children, early posture control, scoliosis, kyphosis, spine deformities, healthy posture.

INTRODUCTION

The deformity of the Spinal Spine is the most ancient disease in the human species. The first documented record of correction of the deformations of the Spinal Spine (S.S.), refers to ancient India books between the period 3,500 and 1,800 BC. Hippocrates is the first healer to correct the deformations of the S.S. using axial pull controls in combination with direct pressure. The early control of the deformities of the S.S. is vital and aims at early diagnosis and better anticipation of musculoskeletal problems in children ((Henschke et al., 2014; Rusnák et al., 2019). As “posture" is defined as the position of members of the body, the correct posture of the body is the position where the joints receive the minimum stress (Alter, 2004).

It is a global problem of postural disorder and
deformities of the S.S. requiring good classification and research methodology. Prevention and early diagnosis are really important to reduce deformities of the S.S. There should be a specialized team to do school screening test and record all details about recognized deformities and update the measurements. The high-risk group should follow a special exercise program. If more severe deviations are observed, orthopedics should be consulted. A previous investigation which examined the effects of backpack weight on adolescents, head and neck posture showed that there was a significant increase of cranio vertebral angle with increasing backpack load and age more in girls than in boys.

The current investigation attempted to correlate the asymmetries in upright position using PSM application and anthropometric features (age, body weight, height, (BMI), weight of the school bag, placement of the schoolbag, deviations of the shoulders relative to the seated position during the study in adolescents.

**Purpose**

The purpose of this study was to screen the asymmetries of the standing position of children in the anterior, posterior, right and left sides, as well as the correlation between the PSM variables, demographic characteristics and answers from the questionnaires answered by parents.

**METHODOLOGY**

The survey was conducted at the football academy of Panachialik in Patras city. The survey lasted from October 2018 to May 2019. The total sample consisted of 30 adolescent boys. The health condition was considered to be very good without injury.

For the purposes of this study, the ages of individuals ranged from 13 to 16 years, with an average age of 14.2 years, an average weight of 56.57 kg. The height was from 1.45 to 1.86 m with an average height of 1.64 m almost equal to the median height (1.65 m). Finally, their BMI was in normal range with a mean BMI of approximately 21 and a standard deviation of 2.56(Table 1).

They participated on a fixed and permanent basis in football academy trainings three times a week for one hour each session. Participating adolescents were randomly selected and written parental permission was requested before student participation. Each participant was selected by the authors. The study included the evaluation of adolescents by generally observing the posture of the body in upright position from the front and back side, checking for shoulder and pelvis asymmetries. We observed deviation of the trunk from the midline and the spinal posture. The adolescents wore only shorts during the examination. Each adolescent was asked questions during the assessment whether they experienced back pain, pain and fatigue after football training, or headache. The height was measured with a wall resuscitation meter of the company “gima Italy” and electronic scale for weight. This was followed by scoliosis test, using the validation test (Adam's Test), during the procedure boys bend forward with their feet and knees stretched. The examiner checks the back area, and used the scoliometer app (iPhone 6) to measure the deviation. No findings were made, deviations of 2-3 degrees were observed. The Posture screen analysis application, the telephone device iPhone 6 was used. Photographs were taken while standing in the front and back side as well as the right and left side position. After collecting images extracted in pdf, the results of the measurements, a questionnaire was given to parents being aware of asymmetries-deformities of the spine as well as the correct posture. The data of the adolescents were known only to the researchers of the study. The aim of this study was to investigate the percentage of children who showed posture asymmetry in standing position, the frequency rate of each asymmetry and whether it affects the child’s daily life and training.

Before each assessment, the room was set up in a standardized way to ensure uniform conditions throughout the test. A tape was placed on the floor to indicate where the subject should stand for the anterior picture. A second piece of tape was laid perpendicular to the first piece to indicate the positioning for the lateral picture. The tablet was placed on a stand exactly 10 feet away from the subject markers at a height of 4.5 feet to standardize the image angle. Subjects were instructed to stand at the tape marks in a comfortable position with weight evenly distributed on both legs and to look at a marker placed on the wall in front of them at eye level. To help eliminate potential deviations from their routine posture, subjects were asked to stand on their right foot for a few seconds and then shift their balance to the left foot for a few seconds. Subjects then placed both feet on the ground and an image was captured using PSM and the camera function of the iPhone 6. This process was repeated to obtain both an anterior and right lateral view of each subject. Three sets of postural images

<table>
<thead>
<tr>
<th>N</th>
<th>Medium</th>
<th>Standard Deviation</th>
<th>Median Price</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(years)</td>
<td>30</td>
<td>14.2</td>
<td>1.16</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>30</td>
<td>56.57</td>
<td>10.24</td>
<td>59.3</td>
<td>34.6</td>
</tr>
<tr>
<td>Height (m)</td>
<td>30</td>
<td>1.64</td>
<td>0.10</td>
<td>1.65</td>
<td>1.45</td>
</tr>
<tr>
<td>BMI</td>
<td>30</td>
<td>20.98</td>
<td>2.56</td>
<td>21.7</td>
<td>16.46</td>
</tr>
</tbody>
</table>
were taken of each subject over two visits. An initial set of images was captured with subjects dressed in standard street clothing with their shoes removed. A second set of images was captured on the same visit with subjects wearing minimal clothing (shorts for men) also with their shoes removed. Subjects were asked to refrain from strenuous physical activity between visits, in order to reduce external factors influencing postural variation.

Three examiners analyzed each set of data by following the PSM prompts to select 17 specific anatomical landmarks. Twelve landmarks were placed on the anterior view image at the following locations: the right pupil, left pupil, midpoint between the nose and upper lip, top of the right acromioclavicular (AC) joint, episternal notch, top of the left AC joint, right lateral rib T8 level, left lateral rib T8 level, right anterior superior iliac spine (ASIS), left ASIS, center of the right talus, and center of the left talus. Five landmarks were placed on the lateral view image at the following locations: the external auditory meatus, center of the shoulder at the cervicothoracic junction, greater trochanter, center of the tibiofemoral joint, and center of the malleolus. PSM then calculated the following 13 quantitative data points using proprietary algorithms: head shift (lateral), head shift (longitudinal), head tilt, shoulder shift (lateral), shoulder shift (longitudinal), shoulder tilt, ribcage shift, hip shift (lateral), hip shift (longitudinal), hip tilt, head weight, effective head weight, defined as how heavy the head feels to its supporting structures based on any postural deviations, and knee shift.

The data were collected from the review of children's assessment through general upright observation and the collection of questionnaires by parents, including epidemiological data (age, sex, weight, BMI, height). Limiting factors in research are important in the results of measurements because no statistically significant differences were found, since they regularly train and have no musculoskeletal problems.

For more reliable results, it may be necessary for the study to use a larger sample as well as a population of the same age but without training activity.

Statistical Analysis

Methods of descriptive statistics for positioning and spreading of all the variables of our study were applied. Then the relations between the variables recorded with the Posture screen, with the demographic characteristics of the other two questionnaires were selected, with statistical methods of correlation but also comparison of average values and fluctuation analysis.

All conditions for application of the statistical tests (regularity of distributions, dispersion equality, etc.) were checked and in case the regularity of the variables was not met in the whole or per group, the variable was converted to a logarithmic scale, in order to implement parametric methods of data analysis. Also, due to the sample size and the uneven distribution of variables, resampling for 10,000 identical samples using the Bootstrap method was used to avoid bias of the results. All statistical tests were performed with the IBM SPSS Statistics ver. 24 and the statistical significance limit for case tests was p = 0.05.

RESULTS

The differences in the weight of the school bag, the placement (one shoulder or two shoulders) and the sitting position during the study are presented below. Table 2 shows the differences in shoulder translation and deviations in relation to the weight of the school bag for thirty children who participated in our study. From the observation of the results, we found that there are differences in movements and deviations but they are not statistically significant (p> 0.05).

It was observed that when the weight of the bag was more than 10% of the child's body weight, total forward, lateral, right and left movements were slightly increased than when the weight of the bag was less than 10% of body weight.

Also the habit of holding the school bag on one shoulder indicates that the movements and deviations of the shoulders could be affected, although they are not statistically significant (Table 3).

Another important factor is the right or wrong posture during the study. From the results of Tables 4 and 5, we found that 23 children in the wrong place have higher deviations than those who were in the right place during the study.

The results of the study showed that there are often interrelated factors that lead to the adoption of a posture error such as:

1. The weight of the school bag. 16 children (53.3%) hold bags that exceed 10% of the weight of the bag which is more than 10% of their body weight. The results of the measurements showed that the total travel to the front, side, right and left were slightly increased than when the weight of the bag was below 10% of the SB (Brackley et al., 2009).

2. Placement of a one-shoulder bag on 16 children (53.3%), holds the bag exclusively on one shoulder, the average movements and the mean deviations on the shoulders were noted relative to the placement of the school bag. According to the results of Table 4, deviations are clearly higher in children holding the bag on one shoulder, but these differences are not statistically significant (p> 0.05).

3. The effect of seated position during reading shows that 23 children (76.7%) adopted the wrong seated position during the study. Initially in terms of overall movements and deviations, there were no statistically significant differences between children who have a correct or wrong seated position during reading. But there were clear differences and far higher displacements and deviations among children in the wrong place.

4. The seated hours with the highest frequency are those of 3 and 4 hours a day.
5. The weight of the school bag along with the books ranges from 3 to 10 kilos with the most weight (53.3%) being between 5 and 6 kg.

6. It is also characteristic that ½ the children hold a school bag that exceeds 10% of their body weight.

7. The wrong body posture is often seen in 30% and 40% of school-age children worldwide, resulting in a change in posture (Bendiková et al., 2014; Jehle and Kühnis, 2011; Kratěnová et al., 2007).

**DISCUSSION**

In this study, it was observed that there is a correlation between total movements and deviations in anterior posterior right lateral posterior and lateral left positions. Compared to previous generations, studies have shown that the number of children with wrong posture is constantly increasing (Lombard, 2016; Mitova, 2015; Kamper et al., 2016). The average values for total translations are a few centimeters. From 0.07 to 0.12 cm in anterior and posterior positions, respectively, with standard deviations of 0.27 and 0.32 cm.

We observed that half the children have movements below 0.02 cm in the anterior position and 0.04 cm in the posterior position. Average movements are almost infinitesimal as well as average shoulder deviations. The children's shoulders in our study recorded a mean displacement of 0.07 cm with a standard deviation of 0.28 cm and a mean deviation of 2.08 degrees with a standard deviation of 1.94 degrees. While half the children had a shoulder shift below 0.02 cm and a deviation below 1.17 degrees.

Regarding total movements and deviations, there were no statistically significant differences between children who have a correct or wrong seated position during the reading. But there were clear differences and far higher displacements and deviations among children in the wrong place.

Compared to total displacements and deviations in relation to seated study duration, another variable that is likely to affect movements and deviations is probably the duration of the study. Indeed, we observed in the results that as the study time increased, overall movements and deviations also increased. However, these deviations are not statistically significant (p> 0.05).

Also, movements and deviations on the shoulders increase as study times increase, but their differences are not statistically significant (p> 0.05).

However, there are differences in overall mean values between these two categories but they are not statistically significant (p> 0.05).

Obesity in adolescents leads to body posture abnormalities (Lombard, 2016). In other research, poor posture occurred in more than 50% of adolescents. They found spinal deformities in the sagittal and frontal planes.

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Table 2. Comparison of movements and deviations of the shoulders in terms of weight of the school bag

<table>
<thead>
<tr>
<th>How many kilos do the books weigh?</th>
<th>3 - 4 Kg</th>
<th>5 - 6 Kg</th>
<th>7 - 10 Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=6</td>
<td>n=15</td>
<td>n=8</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>F</td>
</tr>
<tr>
<td>Shoulder Anterior Translations</td>
<td>0.005 (0.008)</td>
<td>0.013 (0.025)</td>
<td>0.005 (0.005)</td>
</tr>
<tr>
<td>Shoulder Anterior Angulations</td>
<td>1.967 (1.66)</td>
<td>1.753 (1.081)</td>
<td>1.325 (0.853)</td>
</tr>
<tr>
<td>Shoulder Right Lateral Translations</td>
<td>0.018 (0.026)</td>
<td>0.126 (0.422)</td>
<td>0.019 (0.01)</td>
</tr>
<tr>
<td>Shoulder Right Lateral Angulations</td>
<td>3.068 (4.295)</td>
<td>2.841 (1.929)</td>
<td>3.235 (1.267)</td>
</tr>
<tr>
<td>Shoulder Posterior Translations</td>
<td>0.012 (0.019)</td>
<td>0.013 (0.036)</td>
<td>0.006 (0.005)</td>
</tr>
<tr>
<td>Shoulder Posterior Angulations</td>
<td>1.35 (1.286)</td>
<td>0.9 (0.824)</td>
<td>1.425 (1.13)</td>
</tr>
<tr>
<td>Shoulder Left Lateral Translations</td>
<td>0.012 (0.015)</td>
<td>0.107 (0.352)</td>
<td>0.018 (0.01)</td>
</tr>
<tr>
<td>Shoulder Left Lateral Angulations</td>
<td>1.99 (2.452)</td>
<td>2.78 (2.03)</td>
<td>2.739 (1.907)</td>
</tr>
</tbody>
</table>

Table 3. Comparison of shoulder displacements and deviations in relation to the weight of the school bag in terms of body weight

<table>
<thead>
<tr>
<th>Comparison of the schoolbag weight as to body weight</th>
<th>&gt;10%</th>
<th>&lt;10%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 14</td>
<td>n = 15</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>t</td>
</tr>
<tr>
<td>Shoulder Anterior Translations</td>
<td>0.013 (0.025)</td>
<td>0.005 (0.005)</td>
</tr>
<tr>
<td>Shoulder Anterior Angulations</td>
<td>1.907 (1.345)</td>
<td>1.436 (0.872)</td>
</tr>
<tr>
<td>Shoulder Right Lateral Translations</td>
<td>0.128 (0.421)</td>
<td>0.016 (0.009)</td>
</tr>
<tr>
<td>Shoulder Right Lateral Angulations</td>
<td>3.139 (3.036)</td>
<td>2.844 (1.434)</td>
</tr>
<tr>
<td>Shoulder Posterior Translations</td>
<td>0.016 (0.037)</td>
<td>0.005 (0.005)</td>
</tr>
<tr>
<td>Shoulder Posterior Angulations</td>
<td>1.293 (0.976)</td>
<td>0.971 (1.052)</td>
</tr>
<tr>
<td>Shoulder Left Lateral Translations</td>
<td>0.105 (0.353)</td>
<td>0.018 (0.011)</td>
</tr>
<tr>
<td>Shoulder Left Lateral Angulations</td>
<td>2.247 (2.151)</td>
<td>2.989 (1.907)</td>
</tr>
</tbody>
</table>
Also spinal and postural disorders were accompanied by imbalance (Mitova, 2015). There are fewer studies that report the incidence of musculoskeletal pain in adolescents (Kamper et al., 2016).

**Conclusion**

The results of the present study showed that the children who participated in the study were found to have clear shoulder differences and significantly higher movements and deviations were found in children who were wrongly seated during the study. It was noticed that when the weight of the bag is over 10% of the child’s body weight, the differences are slightly higher than when the weight of the bag is below 10% of BW. The 16 children (53.3%) held the bag exclusively on one shoulder, the values of the asymmetries are clearly higher, but these differences are not statistically significant. Korovessis et al. (2004), showed that in the age range of 9-15 years, tall children carrying their backpack to school do not experience much more dorsal pain or low back pain than short children. A previous study that examined the effects of backpack weight on adolescents’ head-on-neck posture showed that there was a significant increase of craniovertebral angle with increasing backpack load and age (Grimmer et al., 1999).

Early control of the attitude of the child’s body is critical to prevent the occurrence of musculoskeletal problems that will develop and possibly remain in adulthood (Hagner et al., 2011; Jankowicz-Szymańska et al., 2019; Maciałczyk - Paprocka et al., 2017).

The role of the Physiotherapist in soccer academies and in all places where children are present is important.

Using the Posture screen Mobile (PSM) application (Hopkins, 2014; Boland et al., 2016; Szucs and Brown, 2018) is an easy way to have a reliable standing-up analysis that is easily implemented by a Physiotherapist without requiring specialized training to use that application. Equally important is to give instructions on how to educate a good standing and sitting position during reading, the weight of the school bag and the right way to wear the school bag.

**Conflict of Interests**

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

**REFERENCES**


