

# INTRARATER AND INTERRATER RELIABILITY OF PHOTOGRAPHIC MEASUREMENT OF UPPER-BODY STANDING POSTURE OF ADOLESCENTS

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## ABSTRACT

**Objective:** The purposes of this study were to determine the intrarater and interrater reliability of a photographic measurement of the sagittal postures of the cervical spine and shoulder, quantitatively characterize the postural alignment of the head and shoulders in the sagittal plane of Portuguese adolescents 15 to 17 years old in natural erect standing, and analyze differences in postural angles between sexes.

**Methods:** This cross-sectional study was conducted in 2 secondary schools in Portugal where 275 adolescent students (146 females and 129 males) aged 15 to 17 years were evaluated. Sagittal head, cervical, and shoulder angles were measured with photogrammetry and the Postural Assessment Software.

**Results:** For interrater reliability, all of the intraclass correlation coefficient (ICC) values for the 3 angles were higher than 0.85. For intrarater reliability, the ICC values for the sagittal head angle, shoulder angle, and cervical angle were 0.83, 0.78, and 0.66, respectively. Mean values of sagittal head, cervical, and shoulder angles were  $17.2^\circ \pm 5.7^\circ$ ,  $47.4^\circ \pm 5.2^\circ$ , and  $51.4^\circ \pm 8.5^\circ$ , respectively. Anterior head carriage was demonstrated by 68% of the adolescents, whereas 58% had protraction of the shoulder(s). Males had significantly higher mean cervical and sagittal head angles.

**Conclusions:** Forward head posture and protracted shoulders were common postural disorders in adolescents 15 to 17 years old, with females revealing a lower mean cervical angle. The intrarater and interrater evaluation of standing sagittal posture of the cervical spine and shoulders by photogrammetry was reliable. (*J Manipulative Physiol Ther* 2015;38:74-80)

**Key Indexing Terms:** Adolescent; Head; Photogrammetry; Posture; Shoulder

Posture has been defined as the alignment of the body segments at a particular time<sup>1</sup> and is an important health indicator.<sup>2</sup> It is believed that an efficient, erect human posture should allow for the maintenance of balance using the least musculoskeletal effort without a feeling of discomfort.<sup>3</sup>

Epidemiological studies have shown a high prevalence of spinal postural deviations in children and adolescents.<sup>4,5</sup> Other outcome studies have shown that musculoskeletal pain has become a major symptomatic complaint among

children and adolescents. The shoulder and neck regions are cited in many references as the areas of greatest discomfort in adults and adolescents.<sup>6-8</sup> For example, Perry et al<sup>6</sup> and Diepenmaat et al<sup>9</sup> reported that the monthly prevalence rates for adolescent neck and shoulder pain are increasing and range between 11.5% and 29%.

Postural assessment through photography may be a simple method that allows the acquisition of quantitative values to define the alignment of body segments. Recent technological improvements have paved the way for the development of reliable and applicable methods to assist in adolescent postural assessment, such as computer-assisted systems for the analysis of posture photographs (photogrammetry).<sup>2,10</sup>

This method has become widely used in the quantitative assessment of postural alignment, with the potential to quantify linear and angular measurements and with the advantage of allowing a record of subtle postural changes and the interrelation between different parts of the human body,<sup>11</sup> which are difficult to measure and register by other means. Specific software has been developed to assist with posture assessment from digitalized pictures, such as the Postural Assessment Software (PAS/SAPO)<sup>10,12</sup>.

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With a quantitative postural assessment method based on the measurement of different postural angles, it may be possible to identify postural problems such as forward head posture and protracted shoulder. Forward head posture includes cervical spine hyperextension and is associated with the shortening of the upper trapezius, the posterior cervical extensor muscles (suboccipital, semispinalis, and splenni), the sternocleidomastoid muscle, and the levator scapulae musculature.<sup>13</sup> This postural deviation can be studied based on the cervical angle,<sup>4,14</sup> which represents the angle formed at the intersection of a horizontal line through the spinous process of C7 and a line to the tragus of the ear, with smaller angles indicating a more forward head posture. Very often, 50° is chosen as a reference angle<sup>14</sup>; and an individual is considered to have forward head posture if the angle is lower than that value.

A protracted shoulder is a forward displacement of the acromion with reference to the seventh cervical spinous process and can be measured by the shoulder angle. It represents the intersection of the line between the midpoint of the humerus (or acromion process) and spinous process of C7 and the horizontal line through the midpoint of the humerus.

Taking into account the importance of measuring postural deviations, the purposes of the present study were 3-fold: (1) determine the intrarater and interrater reliability of a photographic measurement of the sagittal postures of the cervical spine and shoulder, (2) quantitatively characterize the postural alignment of the head and shoulders in the sagittal plane of Portuguese adolescents 15 to 17 years old in natural erect standing, and (3) analyze differences in postural angles between sexes.

## METHODS

### Ethics

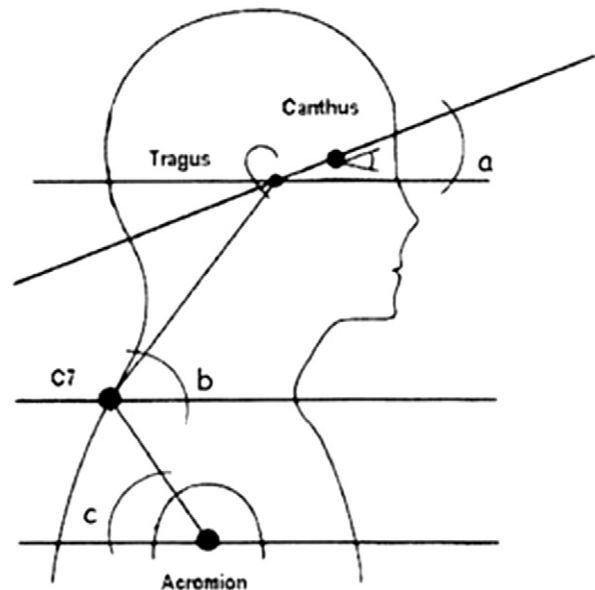
The study was approved by the Research Ethics Committee of the Faculty of Human Kinetics of the Technical University of Lisbon. The participation of all students was voluntary, and written informed consent was obtained from all participants and their parents or legal guardians.

### Setting

This cross-sectional study was conducted in 2 public secondary schools, Lumiar Secondary School and Padre Antonio Vieira Secondary School, located in the city of Lisbon, Portugal. The choice of these schools was based on geographical issues and focused on the center of Lisbon.

### Participants

Male and female adolescent students between the ages of 15 and 17 years were eligible to participate. Participants were excluded if they had visual deficits, had diagnosed balance disorders, or were nonambulatory. Additional



**Fig 1.** Sagittal head angle, cervical angle, and shoulder angle.

exclusion criteria were the presence of musculoskeletal pathologies, such as a history of shoulder surgery, current shoulder pain limiting activities, cervical or thoracic fracture, displayed functional or structural scoliosis, or excessive thoracic kyphosis. Given these criteria, a total of 275 adolescent students (146 females and 129 males) aged 15, 16, or 17 years old ( $15.76 \pm 1.08$  years) from 17 different classes (9 from the 10th grade, 7 from the 11th grade, and 1 from the 12th grade) were evaluated and included in the study.

### Procedures

Standing cervical and shoulder posture was measured with photogrammetry and PAS. Three angles of measurement were used: sagittal head angle, cervical angle, and shoulder angle. We chose these angles because they had been used in previous studies and were found to be reliable,<sup>4</sup> enabling the comparison of results. The angles (Fig 1) in the sagittal view were obtained as follows:

**Sagittal Head Angle.** It is the angle formed at the intersection of a horizontal line through the tragus of the ear and a line joining the tragus of the ear and the external canthus of the eye.

**Cervical Angle.** The cervical angle is used to assess the forward position.<sup>4,14</sup> It is the angle formed at the intersection of a horizontal line through the spinous process of C7 and a line to the tragus of the ear. In this study, if the angle was less than 50°, the participant was considered to have forward head posture. The selection of 50° as a reference angle was guided by the studies of Diab and Moustafa<sup>14</sup> and Yip et al,<sup>15</sup> with the latter reporting  $55.02 \pm 2.86$  as a reference range. As is well known, participants

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