J. Phys. Ther. Sci.
24: 391–394, 2012

Quantitative Assessment of Head Posture of Young Adults Based on Lateral View Photographs

Afaf A M Shaheen[1)], Reem M Basuodan[2)]

[1)] *Department of Basic Sciences, Faculty of Physical Therapy, Cairo University: 7 Ahmed Elziat Street, Giza, Egypt. TEL: +966 1-286257, FAX: +966 1-4355370, E-mail: afaf _pt@yahoo.com*
[2)] *Malaz Rehabilitation Center*

Abstract. [Purposes] the aims of the present study were to quantitatively characterize upright static sagittal head posture and to determine differences among children according to their age and sex. [Subjects and Methods] This cross-sectional study was conducted on 186 Arabic school children of both sexes aged between 7 to 9 years. They were photographed with a digital camera while maintaining a natural static upright position. The value of cranio-vertebral angle was calculated using Able Image Analyzer software. [Results] The results revealed a non-significant effect of age and a highly significant effect of sex on head posture. Moreover, a significant effect of age × sex interaction was also shown. [Conclusion] Head posture varies considerably with the sex of children aged 7 to 9 years old. This study may serve as a guideline for physiotherapists and clinicians when conducting head posture assessments and in clinical decision making regarding possible interventions.
Key words: Head posture, Craniovertebral angle, Children

(This article was submitted Nov. 16, 2011, and was accepted Dec. 13, 2011)

INTRODUCTION

Posture is defined as the relative arrangement of body parts. Good posture is a state of muscular and skeletal balance that protects the body structures against injury or progressive deformity[1)]. Bad posture is a defective relationship between several parts of the body that produces greater tension in the supportive structures, and where a less efficient body balance on the supportive base occurs[1)]. There are intrinsic and extrinsic factors that can influence a subject's posture, such as heredity, the environment or physical conditions in which the subject lives, socioeconomic level, emotional factors, and physiologic alterations due to human growth and development[2)].

Quantitative data on the postural alignment of growing, healthy children are scarce and the reference values for misalignments are based on the posture of the adult population[3, 4)].

Cervical posture of an erect human body is believed to provide an external approximation of the positions that the cervical structures adopt when supporting the head against gravity[5)]. The most common objective measurement of cervical posture in the sagittal plane is that of external variation of head and neck alignment with the subject in standing position. One objective method of assessing head posture is through measuring the craniovertebral angle (CV angle)[6)].

The CV angle is defined as the angle formed between a horizontal line passing through the C7 spinous process and a line passing through the tragus of the ear. It is a reliable indicator of variations in head and neck posture and it is believed to provide an estimation of neck position on the upper trunk. Smaller CV angles indicate greater protraction or forward head posture (FHP) and larger angles are more representative of 'ideal' sagittal plane head/neck alignment[6)].

Several methods have been used to assess the alignment of head posture such as visual analysis, X-rays[4)], video cameras and goniometry[7, 8)]. The use of photography as a postural record is recommended for its simplicity and low cost and it offers the possibility of creating a database to follow postural development[2)] and, therefore, observe subtle modifications[9)].

Normal changes in CV angle values in adults can result from aging or differences between men and women[10)]. Little description of the quantitative analysis of head posture and its correlation with the age and sex of children has been found in the literature[11)]. Furthermore, upright posture measurements of children and adolescents might be a useful clinical tool for identifying musculoskeletal conditions at early stages during the developmental process, and as an aid in the identification of preventive measures.

Considering the lack of information on postural changes, particularly the head on the neck or CV angle among Arabic school children, the purposes of this study were to quantitatively characterize upright static sagittal head posture and to determine differences and their correlation with age and sex.

SUBJECTS AND METHODS

A cross-sectional study was carried out on a total of 186 healthy school age children of both sexes aged between 7 to 9 years who had a body mass index (BMI) percentile <

Table 1. Descriptive statistics for age, height, weight, BMI percentile, and CV angle according to age and sex

	Group I 7 to < 8 years		Group II 8 to ≤ 9 years		Total 7 to ≤ 9 years		
	Mean ± SD		Mean ± SD		Mean ± SD	Min.	Max.
Sex	Boys (40)	Girls (49)	Boys (58)	Girls (39)			Total (186)
Age (yr)	7.42 ± 0.29	7.45 ± 0.29	8.35 ± 0.27	8.48 ± 0.32	7.95 ± 0.56	7.0	9.0
Weight (Kg)	24.5 ± 3.8	25.9 ± 3.9	26.9 ± 3.6	28.2 ± 4.1	26.4 ± 4.0	17.8	39.4
Height (cm)	123.4 ± 5.9	126.0 ± 5.9	128.5 ± 5.7	129.5 ± 4.7	126.9 ± 6.0	113.7	146.5
BMI (%)	52.4 ± 25.2	56.5 ± 30.0	50.3 ± 23.0	56.3 ± 25.5	53.7 ± 25.9	5.0	94.0
CV angle(º)	50.0 ± 4.7	45.6 ± 4.4	48.2 ± 4.1	47.5 ± 4.8	47.7 ± 4.7	36.1	59.7

SD: Standard deviation, Min.: minimum, Max.: Maximum, Yr: Year, Kg: Kilograms, cm: Centimeter, %: percentile, º: Degree

95th[12]. They were recruited from seven primary schools in the middle and the west regions of Riyadh. Ethical approval was obtained from the schools authorities.

The children were examined according to a well designed screening sheet and the children who met the entry criteria were divided according to their age into two groups (I and II). Group I consisted of 89 children, 40 boys and 49 girls, from 7 to < 8 years. Group II consisted of 97 children, 58 boys and 39 girls, from 8 to ≤ 9 years.

Children of 7–9 years have the advantage of mature standing stability and are at an age before the growth spurt which occurs between 11 and 14 years in boys and between 10 and 13 years in girls. This age group also has the advantage of being in the second postural developmental phase in which children become able to maintain head stabilization in space even when balance difficulty increases, for example while walking on narrow supports.

Children were excluded from the sample if they presented any neuromuscular, musculoskeletal, cardio-respiratory or mouth breathing disorders[13], or had congenital or acquired postural deformity, or any visual impairment not corrected by glasses[14], or a BMI percentile above 95th.

The children's parents were notified about the research by means of a letter supplying information about the head postural examination. Children were examined following the screening sheet and interviews were held with parents/guardians to identify the exclusion criteria. Before their children were included in the study, parents/guardians were asked to sign and return an informed consent form.

The children were assessed in a specially prepared lab where the children were instructed to remove their shoes and to stand on the weight and height scale (Cardinal Detecto ProDoc Series Physician Digital Scale). The height in centimeters and weight in kilograms were measured and the calculation of the BMI percentile for each child was performed using the internet website www.apps.nccd.cdc.gov by entering the child's sex, height, weight, Gregorian examination date, and Gregorian birth date.

The image used for CV angle measurement was captured by a digital camera (Olympus Stylus 1000) positioned on an adjustable tripod 200 cm from the child and 225 cm from the wall. The children were asked to put on sportswear in order to expose their neck and the upper thoracic spine. They were also required to remove their socks and shoes. The seventh cervical (C7) spinous process was palpated and identified and an adhesive small spherical marker 5 mm in diameter was attached over the midpoint of the most prominent part. Another marker was fixed to the tragus of the left ear. The children were instructed to stand comfortably with their weight distributed evenly on both feet and to keep their eyes looking straight ahead at a mirror[10, 15].

The photographic data were exported from the camera to a laptop PC via USB-data transfer cable. The vertical and horizontal co-ordinates of the center of C7 spinous process anatomical landmark on each photograph were identified and the CV angle of each child was quantified in degrees using Able Image Analyzer software version 3.6.

After checking the normality with the Kolomogrov-Smirnov (KS) test, all data were expressed as mean and standard deviation. The independent samples t-test was employed to test the effect of age and sex on head posture. Two-way factorial analysis of variance ANOVA was conducted to test the main effects of age, sex, and the possible age × sex interaction. A confidence interval of 95% was assigned, therefore p values ≤0.05 were considered significant. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 17.

RESULTS

The children's characteristics and mean values of CV angles are presented in Table 1. All tested variables were normally distributed according to the KS test ($p > 0.05$).

The results of the independent samples t-test revealed a tendency of difference between the two age groups (7 to <8 years and 8 to ≤9 years) ($t = 0.569$, $P = 0.570$).

However, there was a statistically significant difference between boys and girls ($t = 3.744$, $P = 0.000$) in which boys showed a greater mean CV angle (48.9° ± 4.4°) than girls (46.4° ± 4.7°) (Table 2).

The two-way ANOVA yielded a statistically insignificant effect of age ($P = 0.945$) and a significant main effect of sex ($P = 0.000$) on head posture. Moreover, significant age × sex interaction was noted ($P = 0.005$).

Table 2. Effect of sex on CV angle: comparison between boys and girls

Sex	No.	Mean ± SD
Boys	98	48.9º ± 4.4º
Girls	88	46.4º ± 4.7º

*p<0.05. SD: Standard deviation, No. number,

DISCUSSION

This study achieved its objectives of quantitatively characterizing the head posture of Arabic children and of identifying differences among children related to age and sex.

It is very difficult to compare the results of this study with those found in the literature because other studies of postural assessment of children have either analyzed the standards and alterations in qualitative ways or used different quantitative methodologies[4, 16].

The present study shows that head posture considerably differs between boys and girls. The values recorded in this study may help to explain the factors that influence the changes of head posture in Arabic school children aged between 7 to 9 years.

The novelty of this study is its application to a sample of Arabic population in attempting to develop a database for Arabic children. It also raises the issue for further studies to determine if there are any differences in the normal value of the CV angle between Arabic and non-Arabic children. In addition the results of the present study demonstrate and emphasis the importance of using a reliable measurement tool in the assessment of children's head posture when estimating the normal value of the CV angle and changes which may be related to age and sex. This should physical therapists to study the effects of many diseases (e.g. respiratory system diseases) on head and neck posture in children.

The results show a statistically insignificant effect of age on head posture. The value of the CV angle was nearly the same in two age groups. It was 48.0° ± 5.0° for children from 7 to < 8 years and 47.6° ± 4.5° for children from 8 to ≤ 9 years. These results are in agreement with those of Penha et al.[11] who found an insignificant effect of age on CV angle in children aged from 7 to 8 years.

Using sagittal plane photographs of upright standing posture of 38 boys and girls aged 5–12 years, McEvoy and Grimmer measured five postural angles (trunk, neck, gaze, head on neck, lower limb). They found that the postural angle of the neck was not significantly influenced by age, furthermore, no sex influence was found[16].

Lafond et al.[3] concluded that postural alignment of children, relative to a vertical reference, changes considerably between the ages of 4 to 12 years, and postural evolution during childhood is characterized by increases in forward translation displacements of the head, shoulders, pelvis and knees in the sagittal plane. The contradiction between the results of the present study with that of Lafond et al.[3] may be due to the wider age range of the children included in their study. Also, part of their data was collected during the growth spurt period from 9 to 12 years which causes widespread alterations in body shape and dimensions and also has an effect on muscle tightness and flexibility.

In addition, the absence of a significant difference in posture pattern between the groups in the present study may be attributable to the height-weight development of the age group, as the posture of children changes in order to adapt to new body proportions, regardless of health, status as well as development of motor control influencing the body's ability to balance against gravity.

In the present study, eight-year-old girls showed a lower CV angle (45.6° ± 4.4°) than boys, indicating a high incidence of FHP when they are subjected to loads (backpacks)[17].

The sex differences were remarkable. In this study, girls showed more considerable differences in CV angle than boys and girls showed a more significant postural change than boys. Girls showed smaller CV angels (46.4° ± 4.7°) and greater FHP than boys (48.9° ± 4.4°).

In agreement with this finding, Grimmer et al.[18] reported that the CV angle value was smaller in girls than boys through 8 to 12 years. Similarly, Phena et al.[11] assessed children aged from 7 to 8 years using a methodology similar to that used in the present study and found a significant effect of sex on head posture. Girls showed more FHP than boys at measured values of (49.6° ± 6.7°) and (52.2° ± 7.6°) for girls and boys, respectively.

On the other hand, McEvoy and Grimmer[17] found that there were no sex differences between five postural angles (trunk, neck, gaze, head on neck, and lower limb) among children aged from 5 to 12 years old.

In the present study, a significant effect of age × sex interaction on CV angle was clearly demonstrated (P=0.005). Younger girls (7.45 ± 0.29 years) showed a smaller CV angle (45.6° ± 4.4°) and more FHP than older girls (8.48 ± 0.30 years) (effect of age) and young boys (7.42 ± 0.30 years) (effect of sex).

It is most noteworthy that the difference of CV angle means increased 1.9° for girls and decreased 1.8° for boys across the age groups. This result is in agreement with Grimmer et al.[18] who found that the mean value of baseline (unloaded) CV angle increased 1.3° for girls and decreased 0.7° for boys across one year. They considered this observation was due to the differential postural response per sex and level of spinal development in children.

The growth and development of the atlanto dens interval, the diameter of the spinal canal, the Torg ratio, the height and width of the second through fifth cervical vertebral bodies, the height of the dens, and the ossification of the first cervical vertebra on serial radiographs made from the age of three months until the age of 15 years were assessed by Jeffrey et al.[19] using a computerized image analyzer. They found nearly equal development of both boys and girls at all time-points.

On the other hand, Greaves et al.[20] showed that cervical kinematics vary with age and sex. They found that both age and sex significantly affect the three dimensional kinematics of the cervical spine. Young girls (7.4 ± 2.1 years) had a more anterior helical axis of motion (HAM) (HAM is the three dimensional analogue to the center of motion) location in flexion/extension compared to young boys (8.5 ± 1.2 years), and the HAM location in axial rotation and flexion /extension was more anterior in young girls (7.4 ± 2.1years) than in adult woman (39.5 ± 9.9) (effect of age), and young boys (8.6 ± 1.2 years) (effect of sex). These previous studies suggest that the CV angle varies with age and sex.

The posture of the head and neck has long been recognized as a factor contributing to the onset and perpetuation of cervical pain and dysfunction[21)]. FHP is one of the common poor head postures seen in patients with neck disorders. A number of studies suggested that FHP predisposes individuals towards pathological conditions such as thoracic outlet syndrome and cervical spondylogenic changes[10, 22)].

Clinicians always try to correct their patients' FHP by various treatment approaches. In order to assess the effectiveness of these approaches, it is vital to verify the factors which influence head posture and to develop an objective method for measuring children.

Accurate assessment of complete head and neck posture requires a cephalometric radiographic analysis which was not available in this study. Moreover, further study may be required to elucidate if there are any differences when the subject is in a standing versus a sitting position for analysis of head posture.

In conclusion, the present study achieved its purposes of quantitatively characterizing the head posture of the children aged between 7 to 9 years old, and of identifying differences in CV angle values between children due to age and sex. This study may provide evidence regarding the factors which may influence head posture in Arabic school children aged from 7 to 9 years. It may serve as a guideline for physiotherapists and clinicians when conducting postural assessments, and in clinical decision making regarding possible interventions as well as providing useful information on which further studies of postural development of children aged from 7 to 9 years can be based.

REFERENCES

1) Penha PJ, João SM, Casarotto RA, et al.: Postural assessment of girls between 7 and 10 years of age. Clinics, 2005, 60: 9–16. [Medline] [CrossRef]
2) Santos MM, Silva MP, Sanada LS, et al.: Photogrammetric postural analysis on healthy seven to ten-year-old children: Interrater reliability. Rev Bras Disinter. Sao Carlos, 2009, 13: 350–355.
3) Lafond D, Descarreaux M, Normand MC, et al.: Postural development in school children: A cross-sectional study. Chiropr Osteopat, 2007, 15: 1. [Medline] [CrossRef]
4) Cil A, Yazici M, Uzumcugil A, et al.: The evolution of sagittal segmental alignment of the spine during childhood. Spine, 2005, 30: 93–100. [Medline]
5) Bogduk N, Mercer S: Biomechanics of the cervical spine.1: normal kinematics. Clin Biomech (Bristol, Avon), 2000, 15: 633–648. [Medline] [CrossRef]
6) Cueung Lau HM, Chiu TT, Lam TH: Clinical measurement of craniovertebral angle by electronic head posture instrument: A test of reliability and validity. Man Ther, 2009, 14: 363–368. [Medline] [CrossRef]
7) Bister D, Edler RJ, Tom BD, et al.: Natural head posture − considerations of reproducibility. Eur J Orthod, 2002, 24: 457–470. [Medline] [CrossRef]
8) Brosseau L, Tousignant M, Budd J, et al.: Intratester and intertester reliability and criterion validity of the parallelogram and universal goniometers for active knee flexion in healthy subjects. Physiother Res Int, 1997, 2: 150–166. [Medline] [CrossRef]
9) Dunk NM, Chung YY, Compton DS, et al.: The reliability of quantifying upright standing postures as a baseline diagnostic clinical tool. J Manipulative Physiol Ther, 2004, 27: 91–96. [Medline] [CrossRef]
10) Silva AG, Punt TD, Sharples P, et al.: Head posture and neck pain of chronic non traumatic origin: A comparison between patients and pain-free persons. Arch Phys Med Rehabil, 2009, 90: 669–674. [Medline] [CrossRef]
11) Penha PJ, Baldini M, Joao S: Spinal postural alignment variance according to sex and age in 7 − and 8 –year-old children. J Manipulative Physiol Ther, 2009, 32: 154–159. [Medline] [CrossRef]
12) Briggs A, Straker C, Greig A: Upper quadrant postural changes of school children in response to interaction with different information technologies. Ergonomics, 2004, 47: 790–819. [Medline] [CrossRef]
13) Neiva PD, Kirkwood R, Godinho R: Orientation and position of head posture scapula and thoracic spine in mouth-breathing children. Int J Pediatr Otorhinolaryngol, 2009, 73: 227–236. [Medline] [CrossRef]
14) Salem OH, Preston B: Head posture and deprivation of virtual stimuli. Am Orthopt J, 2002, 52: 95–103. [Medline] [CrossRef]
15) Mohan M, Singh U, Quddus N: Effects of backpack loading on cervical and shoulder poster in Indian school children. Indian J Physiotherapy Occup Ther, 2007, 1: 1–9.
16) McEvoy MP, Grimmer K: Reliability of upright measurement in primary school children. BMC Musculoskelet Disord, 2005, 6: 35. [Medline] [CrossRef]
17) Grimmer K, Milanese S, Louw Q.: Measurement of cervical posture in the sagittal plane. J Manipulative Physiol Ther, 2008, 31: 509–517. [Medline] [CrossRef]
18) Grimmer-Somers KA, Williams M, Gill T: The association between adolescent head-on-neck posture, backpack weight, and anthropometric features. Spine, 1999, 24: 2262–2267. [Medline] [CrossRef]
19) Jeffrey C, Stephen L, John E, et al.: Growth and development of the pediatric cervical spine documented radiographically. JBJS, 2001, 83: 1212–1218.
20) Greaves LL, Toen C, Melnyk A, et al.: Pediatric and adult three-dimension cervical spine kinematics. Spine, 2009, 34: 1650–1657. [Medline] [CrossRef]
21) Harrison DE, Haas JW, Harrison DD, et al.: Sagittal skin contour of the cervical spine: Interexaminer and intraexaminer reliability of the flexi curve instrument. J Manipulative Physiol Ther, 2005, 28: 516–519. [Medline] [CrossRef]
22) Persson PR, Hirschfeld H, Nilsson-Wikmar L: Associated sagittal spinal movements in performance of head pro- and retraction in healthy women: A kinematic analysis. Man Ther, 2007, 12: 119–125. [Medline] [CrossRef]