Scientific Research and Essays Vol. 7(4), pp. 437-440, 30 January, 2012
Available online at http://www.academicjournals.org/SRE
DOI: 10.5897/SRE10.509
ISSN 1992-2248 ©2012 Academic Journals

Full Length Research Paper

Diurnal variation in stature in Nigerian children

Daniel T. Goon[1]*, Abel L. Toriola[2] and Simon W. Akusu[3]

[1]Centre for Biokinetics, Recreation and Sport Science, University of Venda, Thohoyandou, South Africa.
[2]Department of Sports, Rehabilitation and Dental Sciences, Tshwane University of Technology, Pretoria, South Africa.
[3]Human Performance Laboratory, Physical and Health Education Unit, Benue State University, Makurdi, Nigeria.

Accepted 8 September, 2011

While total stature has been demonstrated to decrease throughout the day, whether a diurnal effect applies to Nigerian children has not been reported, the aim of this study was to investigate diurnal stature variation in school children in Makurdi, Nigeria. The stature of 625 children aged 9 to 16 years were measured twice (morning and afternoon) on the same day with a wall mounted stadiometer. The first measurements were taken between 07:00 and 09:00 h and the second measurements between 12:00 and 14:00 h. Differences in children's stature measurements differences were 0.0 to 0.6 cm and a mean of 0.03 ± 1.05 cm decrease was observed. Diurnal variation of stature is confirmed among Nigerian children living in Makurdi. Little differences in stature evaluation could be important in assessing short children in clinical examinations. The present data provides a baseline data for further studies examining this phenomenon in children or adults in other ethnic groups using different designs.

Key words: Children, diurnal variation, stature.

INTRODUCTION

Stature is the most often used anthropometric dimension and it is a quantitative measure of physique and indicative of physical growth and development of an individual. Anatomically, it is a composite of linear dimensions of skull, vertebral column, pelvis and legs (Krishan and Vij, 2007). Diurnal variation in stature first described by Wasse in 1726 (Tanner, 1981) is one of the potentially important source of error, particularly in the estimation of short-term growth (Tillmann and Clayton, 2001). The average daily loss in stature has been shown to vary between 0.46 to 1.54 cm (Ashizawa and Kawabata, 1990; Lampl, 1992; Voss and Bailey, 1997; Siklar et al., 2005). The wide variation is attributed to the differences in the time of day at which the measurements were taken and to differences in measurement method. Some studies have examined the diurnal variation in stature between morning and evening measurements (Ashizawa and Kawabata, 1990; Lampl, 1992; Siklar et al., 2005) or during the first 6 to 8 h after rising (Voss and Bailey, 1997). It has been agreed that the greater proportion of the decrease in stature occurs early in the morning shortly after rising (Kanlayanaphotporn et al., 2003; Fowler et al., 2005; Healey et al., 2005). Conversely, previous studies have indicated that the total body stature decreases during the course of the day and that stature is regained over night when in recumbent postures (Leatt et al., 1986; Wilby et al., 1987) and that stature loss diminished decrementally throughout the day. Measurement of stature is essential for evaluating growth in childhood (Pietrobelli and Tato, 2005; Siklar et al., 2005), calculation of nutritional indexes of children and adults, for prediction and standardisation of physiological parameters such as lung volumes, muscle strength, glomerular filtration, metabolism rate as well as for adjustment of drug dosage in patients (Zverev, 2003). As such, inaccurate stature measurement may lead to inability to detect growth disorders or inappropriate referrals for normally growing children (Grimberg and Lifshitz, 2007). Thus, this underscores the need for accuracy of stature measurements in children.

The time of stature measurement and the importance of diurnal variation have often been neglected in children. Additionally, there is rarely any report about diurnal differences of children from Nigeria. In view of the accountable and significant variations in stature of an

*Corresponding author. E-mail: Daniel.goon@univen.ac.za. Tel: +27 15 962 8076.

individual at different times of the day, the study may be useful to scientists, researchers and clinicians engaged in conducting community based surveys involving stature as a parameter for making reference data pertaining to growth, development and nutritional studies as well as for personal identification in forensic investigations. Therefore, the purpose of this study was to investigate the degree of differences in daily stature measurements in a large group of children.

MATERIALS AND METHODS

Participants and sampling

This cross-sectional study involved 625 children (309 boys and 316 girls) between the ages of 9 to 16 years of age who were drawn from five geographical regions in Makurdi town, Benue State, Nigeria. 10 schools were randomly selected from a total of 38 schools in Makurdi town. A two-stage probability sampling technique was used. The first stage included the selection of schools and the second stage consisted of random sampling of participants from the total enrolment in their schools. A representative sample of the schools from the area was drawn based on the official list obtained from the Benue State Universal Basic Education Board. A total of 10 public primary schools were randomly selected within the five geographical areas of Makurdi town. 2 schools were selected in each geographical region to participate in the study. Participants were also randomly selected by simple randomisation technique. In all selected, school children within the ages of 9 and 16 were eligible to participate in the study. There was no specific reason regarding the age range (9 to 16 years) of the participants. It was thought that children in the lower classes do close earlier; as such, it would be difficult getting them to stay back for the afternoon measurement ending at 14:00 h. The sample included all children in attendance at the school at the time of the survey which was carried out in February 2009. Inclusionary criteria were children in primary 4 to 6 classes and without any deformity that could affect stature measurement. A total of 701 children were selected to participate in the study. However, due to absenteeism and incomplete data of 53 participants, 625 participants (309 boys and 316 girls) eventually completed the tests and their data were used in the final statistical analysis.

Written informed consent was obtained from the participants' parents or guardians and individual head teachers. Permission for the study was granted by the Benue State Universal Basic Education Board. The study followed the principles of the Helsinki declaration.

Stature measurement

Stature was measured according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2006). Stature was measured to the nearest 0.1 cm in bare feet with the children standing upright against a wall mounted stadiometer. Participants stood bare-foot with feet together on a level cemented floor, with upper backs, buttocks and heels touching the wall. Participants' head were held erect and the eyes looking forward. The lower margin of the eye socket (orbitale) and the tragion (the notch superior of the tragus of the ear) were in the Frankfort plane. Each participant's stature was measured twice in the same day. The first measurements were taken between 07:00 and 09:00 h and the second testing between 12:00 and 14:00 h. All measurements were made by the same observer (DTG) to avoid inter-observer error. The observer had special training in anthropometry as a Level II (ISAK) Criterion Kinanthropometrist. To avoid measurement bias, the reliability of the each successive measurement was recorded independently of the previous measurement that is the measurement was recorded 'blindly'. This means that the observer was unaware of the results of the first set of measurements.

Statistical analysis

All values are expressed as means ± standard deviation (SD). Differences in the children's morning and afternoon statures were evaluated using paired *t*-test. Stature differences between the boys and girls were compared by Student's *t*-test and between the age groups, one-way ANOVA was computed. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 16.0. The level of significance was set at $p \leq 0.05$.

RESULTS

The mean age of the participants was 9.9 ± 2.4 years. Stature measurements taken in the morning (first) were 142.9 ± 9.2 cm in boys and 145.9 ± 7.9 cm in girls ($p < 0.01$) and the mean stature in all participants was 144.4 ± 8.7 cm. The second stature measurements were 142.8 ± 9.0 cm in boys and 146.0 ± 7.9 cm in girls ($p = 0.003$) and the mean stature in all children was 144.4 ± 8.6 cm (Table 1). The daily stature measurements indicated differences of 0.06 cm. In 105 children, there was no difference; in 146, there was an increase and in 274 stature, measurements decreased. The total mean diurnal variation of stature was 0.03 ± 1.05 cm for all participants (boys 0.08 ± 0.9 and girls -0.02 ± 1.09 cm). Stature decrement (result of mean differences) was statistically non significant ($p = 0.453$) (Table 1). Diurnal stature variations by age groups are presented in Table 2. No statistically significant difference in diurnal variation of statures between the boys ($p > 0.05$), between the girls ($p > 0.05$) and overall groups ($p > 0.05$) were found.

DISCUSSION

Diurnal decline in stature is an important phenomenon which must be considered during growth assessment (Voss and Bailey, 1997). Very little measurement differences in stature could result to a child being normal or abnormal. Therefore, growth velocity of a child is very crucial particularly during follow-up growing of a child. Numerous studies indicated that diurnal change of stature occurred in children (Lampl, 1992; Voss and Bailey, 1997; Tillman and Clayton, 2001; Siklar et al., 2005; Krishan and Vij, 2007). However, we believe our sample size is larger than those reported in previous studies. Additionally, this cross-sectional study provides us with the results of diurnal differences in stature of children of different age groups living in Makurdi which information is lacking. The present participants showed loss of 0.6 cm in the interval 07:00 to 14:00 h. This is

Table 1. Diurnal differences in stature measurements in children.

Variable	Morning stature (cm)	Afternoon stature (cm)	Minimum differences (cm)	Maximum differences (cm)	Mean diurnal differences (cm)	p-value
Boys (n = 309)	142.9 ± 9.2	142.8 ± 9.0	0.2	0.4	0.08 ± 0.9	0.128
Girls (n = 316)	145.9 ± 7.9	146.0 ± 7.9	-0.2	0.2	-0.02 ± 1.09	0.719
Total (n = 625)	144.4 ± 8.7	144.4 ± 8.6	0.0	0.6	0.03 ± 1.05	0.453

*statistically significant at p ≤ 0.05.

Table 2. Diurnal change in stature measurements according to sex and age groups.

Age	n	Boys	n	Girls	n	Total
		Diurnal changes (cm)		Diurnal changes (cm)		Diurnal changes cm)
9	38	0.02 ± 0.14	15	0.05 ± 0.16	53	0.03 ± 0.15
10	45	0.03 ± 0.28	44	0.05 ± 0.59	89	0.04 ± 0.45
11	47	0.06 ± 0.21	64	-0.01 ± 0.65	111	0.02 ± 0.51
12	63	-0.03 ± 0.42	68	-0.23 ± 2.18	131	-0.13 ± 1.60
13	46	-0.02 ± 0.43	57	0.44 ± 0.34	103	0.02 ± 0.38
14	37	-0.02 ± 0.41	43	0.07 ± 0.34	80	0.03 ± 0.38
15	23	1.05 ± 3.37	22	0.32 ± 0.37	45	0.55 ± 2.45
16	10	0.14 ± 0.18	3	-0.17 ± 0.29	13	0.07 ± 0.24

comparable to the findings of Siklar et al. (2005) study which determined 0.5 cm reduction in stature in children aged 3 to 15 years. Krishan and Vij (2007) measured a nine-year old child four times in a day for 56 days and found a decrease of 1.95 cm in stature. Ashizawa and Kawabata (1997) measured two siblings daily (morning and evening) during a year. Shortening of stature of 10 mm was reported in this study and diurnal variation was stable throughout the year. They attributed diurnal variation in stature to shortening of the trunk length during the day time. However, stature gain occurs after naps or lying down (Kobayashi and Togo, 1993). There were no differences between the age groups concerning daily stature loss. Some children showed an increase in stature, probably because of resting prior to the measurement. However, measurements were not performed in the children after rising to determine the exact difference of diurnal variation; like is obtainable in clinical practice where children's stature is determined at least 1 or 2 h after rising. There was a slight difference of diurnal variation in stature between boys and girls. Girls were taller than boys and hence had greater variation in stature. This variation may also be attributed to larger body mass of the participants. However, this should be seen as only speculative since such conclusion is beyond the data available here. Comparatively, greater diurnal variation in stature among the female participant of this study is intriguing based on two scenarios. Genetically, females are generally better canalized thus should have shown less diurnal variation in stature. Additionally, if one assumes that females are not as involved as their male counterparts in activities that result in compression of the vertebral column and other joints in the body, the greater variation in their stature is unexpected as diurnal variation in stature is affected by the intervertebral discs with loading of the spine during the day (Puntumetakul et al., 2009).

Consequently, measures of stature have been used as proxy measures of spinal loading (Reilly and Freeman, 2006). Recently, several techniques like magnetic resonance imaging (MRI) and ultrasound are utilised to assess the diurnal loss in intervertebral discs stature (Ledsome et al., 1996; Park, 1997). Many factors could affect stature measurements. The instrument, observer, child factors, accurate installation of the measuring instruments, blind measurement and good reproducibility of measurements are very important. The greatest source of variability is the children themselves (Siklar et al., 2005). Correct installation of measuring techniques was ensured and all measurements were taken by a trained anthropometrist, and good measurement reproducibility was reached.

Conclusion

Our study indicated minimal diurnal variation in stature in Nigerian children, thus confirming the notion of diurnal variation in stature. The present data provides a baseline data for further studies examining this phenomenon in children or adults in other ethnic groups using different designs.

ACKNOWLEDGEMENTS

We thank all the children for their participation in this study and the Benue State Universal Basic Education Board Makurdi for granting permission to undertake the study.

REFERENCES

Ashizawa K, Kawabata M (1990). Daily measurements of the heights of two children from June 1984 to May 1985. Ann. Hum. Biol., 17: 437-443.

Fowler NE, Rodacki CL, Rodacki AL (2005). Spinal shrinkage and recovery in women with and without low back pain. Arch. Phys. Med. Rehab., 86: 505-511.

Grimberg A, Lifshitz F (2007). Worrisome growth. In: Lifshitz F. Growth, adrenal, sexual, thyroid, calcium, and fluid balance disorders. 5th ed. New York, NY: Informa Healthcare, pp. 1-50.

Healey EL, Fowler NE, Burden AM, McEwan IM (2005). The influence of different unloading positions upon stature recovery and paraspinal muscle activity. Clin. Biomech., 20: 365-371.

Kanlayanaphotporn R, Trott P, Williams M, Fulton I (2003). Effects of chronic low back pain, age and gender on vertical spinal creep. Ergonomics, 46: 561-573.

Kobayashi M, Togo M (1993). Twice-daily measurements of stature and body weight in two children and one adult. Am. J. Hum. Biol., 5: 193-201.

Krishan K, Vij K (2007). Diurnal variations of stature in three adults and one child. Anthropologist, 9: 113-117.

Lamp M (1992). Further observations on diurnal variation in standing height. Ann. Hum. Biol., 19: 87-90.

Leatt P, Reilly T, Troup JDG (1986). Spinal loading during circuit weight-training and running. Brit. J. Sports Med., 20: 119-124.

Ledsome JR, Lessoway V, Susak LE, Gagnon FA, Gagnon R, Wing PC (1996). Diurnal changes in lumbar intervertebral distance, measured using ultrasound. Spine, 21: 1671-1675.

Marfell-Jones M, Olds T, Stew A, Carter L (2006). International standards for anthropometric assessment. Australia: The International Society for the Advancement of Kinanthropometry.

Park CO (1997). Diurnal variation in lumbar MRI. Correlation between signal intensity, disc height, and disc bulge. Yonsei. Med. J., 38: 8-18.

Pietrobelli A, Tato L (2005). Body composition measurements: From the past to the future. Acta Padiatrica, 94: 8-13.

Puntumetakul R. Trott P, Fulton WI (2009). Effect of time of day on the vertical spinal creep response. Appl. Ergon., 40: 33-38.

Reilly T, Freeman KA (2006). Effects of loading on spinal shrinkage in males of different age groups. Appl. Ergon., 37: 305-310.

Siklar Z, Sanli E, Dallar Y, Tanyer G (2005). Diurnal variation of height in children. Paediatr. Int., 47: 645-648.

Tanner JM (1981). A history of the study of human growth. Cambridge: Cambridge University Press.

Tillmann V, Clayton PE (2001). Diurnal variation in heights and the reliability of height measurements using stretched and unstretched techniques in the evaluation of short-term growth. Ann. Hum. Biol., 28: 195-206.

Voss LD, Bailey BJR (1997). Diurnal variation in stature: is stretching the answer? Arch. Dis. Child., 77: 319-322.

Wilby J, Linge K, Reilly T, Troup JDG (1987). Spinal shrinkage in females: circadian variation and the effects of circuit weight-training. Ergonomics, 30: 47-54.

Zverev YP (2003). Relationship between arm span and stature in Malawian adults. Ann. Hum. Biol., 30: 739-743.