

## DIURNAL VARIATION OF HEIGHT IN SOUTH INDIAN ADOLESCENT SUBJECTS

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### ABSTRACT

The linear height of an individual is considered a reliable measure of physical growth and development. It has significant implications in medicolegal and forensic examination. The aim of the present study was to establish diurnal variation of stature in adolescent Indian subjects. A total of 60 adolescents aged between 13 years to 19 years with equal number of male and female individuals enrolled for the present study. The heights of subjects were measured at 9.00hrs and 16.00hrs using Freemans body meter measuring tape with wall stop for 5 days. The data collected was thoroughly screened and subjected to statistical analysis. Results revealed diurnal variation in height among each individual and also significant difference in diurnal variation of stature between male and female. The present study has important implication with respect to recruitment of individuals for service as well as in forensic medicine for personal identification.

**KEY WORDS:** Diurnal variation, stature, physical growth, anthropology, forensic medicine.

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### INTRODUCTION

Man's habits are governed largely by regular environmental and social rhythms. A circadian rhythm is any biological process that displays an endogenous oscillation of about 24 hours. These 24-hour rhythms are driven by a circadian clock, and they have been widely observed by humans. *Diurnal* can also be used to describe something that has a daily cycle. As the word is

also used to distinguish night and day; Conroy & Mills (1970) preferred the use of circadian to indicate a period of approximately 24 hours [1]. Recently there has been a significant upsurge in interesting diurnal variation or changes especially as they relate to changes in height, the disc; and to some extent; to joint ranges. Height is the measure of vertical distance, either how "tall" something is, or how "high up"

it is. Height 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. Diurnal variation in stature was first noted in 1726 has, however, been largely ignored in clinical practice [2]. Early studies, reviewed by Redfield and Meredith and Boyd, were conducted with varying degrees of scientific rigor, but did confirm the presence of diurnal variation in the adult [3, 4]. Most agreed that the total loss mounted to between 2 and 3 cm, and the evidence suggested that the greater proportion of the decrease in height was occurring in the trunk. Similar effects have been shown in children also [5-10]. Almost all studies report that stature is maximum in the morning and less by 1.5 cm to 3.0 cm in the evening, the studies further confirm that greater proportion of decrease in height is occurring in the vertebral column due to reduction of elasticity of inter-vertebral discs [3, 6, 9, and 11]. Some studies showed that height can be restored by taking short naps [4,12].

The substantial effects of gravity on body height are exemplified by astronauts who apparently show increases of up to 10 cm on returning to earth [13]. Diurnal changes in lumbar flexion have been confirmed but only two measures were made, one in the early morning and one in the afternoon [14]. These authors interestingly found that the early morning result, taken 1.0 minutes after rising, could also be achieved up to 2 hours after rising on subsequent measures, by getting the subject to lie down before the test for a period of time equal to the time spent between rising and lying down.

The aim of the present study was to examine and confirm the diurnal variation of stature in adolescent Indian subjects.

## MATERIALS AND METHODS

The data for this study were obtained from a total of 60 adolescents; aged 13-19 years. An equal number of males and females enrolled in the study with parental permission.

Written consent was obtained from all the subjects at the time of screening, and from the

Institutional Ethical committee of Sree Balaji Medical College for the study. Armamentarium: Freemans measuring tape, Recording sheet, Computer.

The heights of subjects were measured at 09:00 hrs and 16:00 hrs using Free mans Body Meter Measuring Tape with Wall Stop for 5 days. During the 5 days period, the stature of each subject was recorded by the same observer to avoid inter-observer error.

With the subject standing with the heels on the floor, but as tall as possible, a rectangular block was placed perpendicular to the wall and flat on the subject's head. A mark corresponding to the height was carefully made on a stationary wallboard. The measurement was repeated in the afternoon by the same observer with the subject standing at the same site.

The collected data were thoroughly screened and entered into MS-Excel spread sheets and analysis was carried out. Means of stature taken at different times of the day for 5 days for each subject were calculated. Differences in the morning and evening heights were recorded in millimeters and the mean was calculated. The calculated mean was analysed using SPSS statistical software.

## RESULTS

**Table 1:** Means of stature taken at separate times of the day for 5 days.

Subject	Age in years	Stature in mm at		Mean stature difference in mm
		0900hrs	1600hrs	
males	15±2.1	1671±102.2	1658±101.91	11±3.40
females	17±1.07	1524±70.44	1517.5±70.31	6.5±2.40
total	16±1.58	1572±109.35	1566±107.86	8±3.64

The data collected from the 60 subjects in the study group (30 males and 30 females) were analyzed. Table 1 presents the means of stature measured at separate times of the day for the 60 subjects. Table 2 presents the results of the paired sample t tests of the difference in the mean height of the participants at 0900 hrs (1584.53mm) and at 1600 hrs (1576.25mm). The results show that there was a significant difference in height ( $p=.0001$ ) between morning and evening among the participants. Table 3 shows the comparison of mean difference of height among males and females. Among males and females also there was significant ( $p=.0001$ )

difference. Graph 1 represents box plot gender wise comparison of stature.

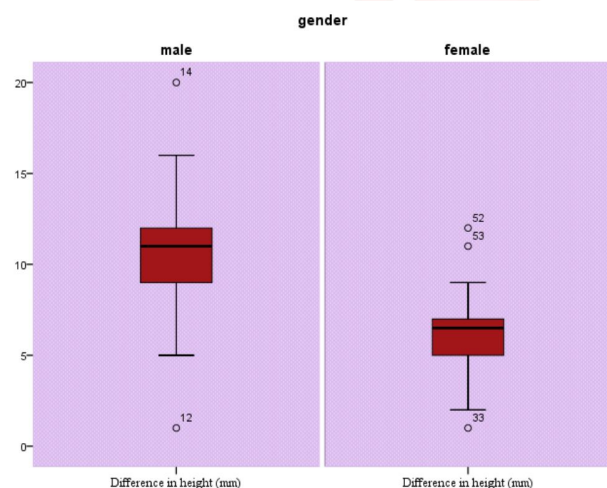
**Table 2:** Paired Samples Statistics.

	Mean	N	Std. Deviation	t	Df	Sig. (2-tailed)
Height(mm) at 9:00Am	1584.53	60	109.349	17.644	59	0.0001
Height(mm) at 4:00Pm	1576.25	60	107.856			

**Table 3:** Comparison of mean difference of height in the morning and evening of males and females.

	Gender	N	Mean difference of height	Std. Deviation	t	df	Sig. (2-tailed)
Difference in Height (mm)	Male	30	10.43	3.401	5.656	58	0.0001
	Female	30	6.13	2.403			

**Graph 1:** Box Plot comparing the stature in the morning and evening among males and females.



## DISCUSSION

Anthropometric dimensions of stature are a quantitative measure of physical growth and development of an individual. Anatomically, it is a composite of linear dimensions of skull, vertebral column, pelvis and legs [15].

There is a definite association between stature and dimensions of various body segments as stated and the results are periodically used in anthropometric studies for physical growth and development of children, medico-legal investigations and personal documentation in forensic examinations by several scientists all over the world [16-19]. Almost all studies report that stature is maximum in the morning and less by 1.5 cm to 3.0 cm in the evening. The difference between recumbent length and stature within an individual has also received substantial attention in the literature [20,21] but at the same time, intra-individual variation in stature has received little attention. Gender difference

in diurnal variation as well has not been studied in detail. In the present study there is a significant diurnal difference in height between male and female. (Table 3). The mean height difference in male taken between 0900hrs and 1600 hrs is 10.43 mm and the mean height difference in female 6.13mm. (Table3).

According to Voss and Bailey (1997) there is no further apparent decrement in stature occurs, once the person has been up for six or seven hours after rising [22], which doesn't support our study. Commonly used, standard stretched technique does not appear to reject the effects of diurnal stature loss. It simply increases the measure height. Some suggest that 'gentle upward pressure on the mastoid processes' could minimize the effects of diurnal variation in stature [23]. Indeed, these authors claim to have shown that using this technique, loss in stature between morning and afternoon, though not entirely eliminated, can be reduced to a maximum of 0.46 cm. In the present study the diurnal variation in height for both male and female show marked increase when compared to previous studies. The increase in male can be attributed to their built and weight and while comparatively female the diurnal variation in height is less the reason may probably be cited with the explanation from the genetics; e.g. females are generally better canalized thus show less diurnal variation in stature. This may also be attributed to the fact that if one assumes that the 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 [15]. Thus, from the present study and previous studies, it is possible to say that height of a person shows diurnal variation irrespective of gender.

The amount and extent of variation depends upon the time of measuring the height and varies from individual to individual. Diurnal stature loss can be a problem in short term longitudinal studies, in which apparent changes might simply reflect variations in the time of the day at which the measurement was taken [24]. This diurnal loss in stature may be attributed to the compression of fibrous discs of cartilage that separate the vertebrae. With the forces of gravity imposed by standing, walking and involving



in physical activity, the discs are gradually compressed [25]. The greater proportion of the change occurs in the vertebral column than in any other part of the body. Some agree that this is due not only to inter-vertebral shortening but also to bending of the vertebral column during the daytime [26] and still others opine the diurnal variation in height is mainly due to loss of fluid from the inter-vertebral discs rather than postural changes (Fairbank, 1998).

## CONCLUSION

Diurnal variation in linear height of an individual may substantially affect the reliability of height data and careful consideration should be given to the time of measurement and also take in to account of the gender difference. Thus the present study will help the scientists, researchers and clinicians engaged in conducting community based surveys involving stature as measurement and for making reference data pertaining to growth, development and nutritional studies, for personal identification in forensic examinations as well as for recruitment of individuals for service.

**Conflicts of Interests: None**

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