

# Sternal Index Indicator of Sex in the Population of Dhanbad District of Jharkhand

Santosh Kumar<sup>1\*</sup>, Makardhaj Prasad<sup>1</sup>

Department of Anatomy, Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand, India 826005

\*Corresponding Author: Dr. Santosh Kumar

Designation: Tutor, Department of Anatomy

## Abstract

Sex determination is a significant step in forensic investigation in remains of unknown human skeletal. The current analysis in this study is an attempt in determination of the sex of the sternum by applying sternal index as one of the parameter in a Dhanbad population of Jharkhand, India. For sexual dimorphism study, Sternal index is calculated in 115 adult sternums which include 75 male and 40 female. The sternal index is given as percentage of the length of manubrium (mm) divided by the length of mesosternum (mm). The sternal index calculated was found to be significantly higher in females; hence the analysis of the data reveals that sex determination cannot be made conclusively from the sternal index in the Dhanbad district of Jharkhand, India. The present study also concludes that the Hyrtl's law applicability in sex determination is limited.

**Keywords:** Forensic anthropometry; Skeletal remains; Identification; Sex determination; Sternal index

Date of Submission: 13-08-2021

Date of Acceptance: 28-08-2021

## I. Introduction

Sex determination is considered as an important factor in forensic investigations of unidentified remains of human skeletal. While discussing on human skeletal sexual dimorphism, Gray's anatomy quotes "Anatomists, anthropologists, and forensic scientists have long judged the sex of skeletal material by non-metrical observations. More recently, sexual divergence has been based upon measurements in many different bones. Such studies emphasize the need for standards of sexual dimorphism in different populations".<sup>1</sup> Wenzel<sup>2</sup> first reported Sexual dimorphism in human sternum and he stated manubrium of different sex is almost of equal length, whereas the mesosternum is proportionately longer in males as compared to females. Hence, this led to Hyrtl's law<sup>3</sup> stating that "the manubrium of sternum of female exceeds half the length of the body, whereas the body in the male sternum is, at least, twice as long as the manubrium".

Determination of sex of the sternum by the length of manubrium, mesosternum, and collectively by the length of manubrium and mesosternum both was reported in the Maharashtrian population of western India.<sup>4</sup> The current analysis in this work focus on attempts to evaluate whether the sternal index is helpful for sexing the sternum in the Dhanbad region of Jharkhand, India. Also in the current study Hyrtl's law applicability in sex determination of Dhanbad population is also studied.

## II. Materials and method

### 2.1 Sampling and Sternal Index

Dried sternums of 115 adult human obtained from cadavers dissected in year 2018 and 2020 were obtained from Shahid Nirmal Mahto Medical College, Dhanbad located in eastern India of Jharkhand third largest district in in terms of population.<sup>5</sup> The sample used was same for determination of sex of the sternum by the length of manubrium, length of mesosternum, and the combined length of manubrium and mesosternum.<sup>4</sup>

For routine dissection studies for bachelor's students of medicine cadavers were bought to above mentioned medical college. The sternums which was fractured and reported with gross pathology were not included in this study. The present study sample involves sternums of individuals of 75 male and 40 female individuals of age group 25-40 years of Dhanbad region of Jharkhand, India. The morphometric specifications of the sternum which encompasses length of manubrium [M], length of mesosternum [B] were measured as described by Ashley<sup>6</sup> in millimeter with the help of vernier calipers.

Sternal Index was calculated as indicated in Eq. 1.

Sternal Index = length of manubrium [M]/length of mesosternum [B] × 100 ... Eq. 1.

The appositeness of Hyrtl's law in determining sex of the sternum in the sample was also studied.

## 2.2 Statistical Analysis

All the studies were carried out in set of three independent measurements. The data recorded were compared and analyzed statistically by Student's t-test. The data was analyzed with the help of Microsoft Excel 2010 and SPSS ver.18 software (Chicago, IL) at the significance level of 0.05.

## III. Results and Discussion

### 3.1. Sternal Index/ Manubrio-Corpus Index

The descriptive statistics of length of manubrium, mesosternum and sternal index was depicted in Table 1. The sternal index varied from 35.1 to 94.1 with a mean value of 60.09 for male sternums, whereas for female sternums sternal index varied from 35.3 to 88 with a mean value of 62.43. Hence the data reveals that the mean value of sternal index for females samples was significantly higher than that those for males samples ( $p = 0.03$ ,  $t = 2.86$ ), which are very similar to data recorded in previous studies.<sup>7-11</sup> Sternal index obtained in the present study was compared with other studies of different Indian population (Table 2).

Mean values recorded for sternal index of male and female sample in this work were greater as compared to other Indian population studies<sup>8-10</sup> reveals differences in population in the sternal index and indicate the application of indices on the population group from which they are derived. Although statistically significant sex differences are evident, sternal index among males and females demonstrate reasonable overlapping. For sternal index distribution of male and female sternums is demonstrated in Table 3. More than one third male sample had sternal index lesser than 55, whereas more than one third female sample had sternal index of greater than 65. Percentage of male and female fell in the range of 55-65 was 44 and 45 percent respectively.

Findings of the present work are similar to those described by Jit et al.<sup>9</sup> who reported statistical difference in the mean values within the range of opposite sex (males 99.68% and females 98.86%) in spite of a high percentage of cases falling.

**Table 1.** Descriptive statistics: sternal measurements (mm) and sternal index in males and females

Parameters	Male (n=75)			Female (n=40)		
	Mean	SD	Range	Mean	SD	Range
Length of Manubrium (M)	52.98	4.86	44-70	45.88	6.27	31-57
Length of Mesosternum (B)	88.16	9.53	64-120	73.48	11.66	41-95
Sternal Index	60.09	08.85	35.1-94.1	62.43	09.31	35.3-88

SD: Standard deviation;  $p < 0.05$ ,  $t = -2.86$

**Table 2.** Comparison of Sternal Index with other Indian studies

Study	Gender	Bones	Ranges	Mean $\pm$ SD	Overlapping Values (%)
Narayan et al. [8]	Male	126	31.72-85.33	54.76 $\pm$ 9.94	
	Female	27	44.33-80.00	58.98 $\pm$ 9.61	
Jit et al. [9]	Male	312	35.00-94.00	55.53** $\pm$ 9.57	99.68
	Female	88	32.00-88.00	61.80** $\pm$ 10.62	98.86
Dahipale et al. [10]	Male	96	36.00-77.00	51.99** $\pm$ 8.34	44.79
	Female	47	51.00-91.00	63.01** $\pm$ 8.50	95.74
Present study	Male	75	35.13-94.10	60.09 $\pm$ 8.85	97.33
	Female	40	35.30-88.10	62.43 $\pm$ 9.31	100.00

SD: Standard deviation.

\*  $p < 0.05$ .

\*\*  $p < 0.001$ .

**Table 3.** Distribution of male and female sternums for sternal index

Sternal Index	Male		Female		Total	
	n	%	n	%	n	%
35-40	12	16	00	00	12	10.43
>40-45	06	8.0	04	10.0	10	8.69
>45-50	01	1.3	09	22.5	10	8.69
>50-55	13	17.3	07	17.5	20	17.39
>55-60	02	2.6	02	5.00	04	3.47
>60-65	20	26.6	06	15.0	26	22.60
>65-70	12	16	09	22.5	21	18.26
>70-75	01	1.3	01	2.5	02	1.73
>75-80	01	1.3	00	00	01	0.86
>80-85	06	8.0	01	2.5	07	6.08
>85	01	1.3	01	2.5	02	1.73

<b>Total</b>	75	100	40	100	115	99.93
--------------	----	-----	----	-----	-----	-------

### 3.2. Hyrtl's law Applicability

Various research studies reveals the Hyrtl's law applicability.<sup>6,8-10,12,13</sup> When Hyrtl's law was used, fourteen and thirty eight sternums of male and female respectively, obeyed the law in our present study. The percent of male (19.177%) accepting the Hyrtl's law is fewer in comparison to other study groups, whereas in case of female it was comparatively higher i.e. 95% than the other study groups. Comparative study of Hyrtl's law applicability in various research studies is depicted in Table 4. It is very apparent from the various Indian population studies that the percent of female sternums adhere to the Hyrtl's law is significantly high<sup>8-10</sup> as compared to African and European study groups,<sup>6,12,13</sup> although for male sternums it is comparably low. Hence it may be signifying racial differences in the sternal index, a fact that needs to be further investigated and proved. However, the law when applied to an individual specimen may not be applicable in sex determination, since most of the sternums lie in the range of the opposite sex.

**Table 4.** Applicability of Hyrtl's law

Study	Gender	Bones (n)	Accuracy of Hyrtl's law (%)
Dwight [12]	Male	30.0	60.0
	Female	26	46.2
Dwight [13]	Male	142	59.1
	Female	86	60.4
Ashely [6]	African Male	85	64.7
	African Female	13	69.2
Ashely [6]	European Male	378	52.9
	European Female	171	69.3
Narayan et al. [8]	Male	126	34.1
	Female	27	81.5
Jit et al. [9]	Male	312	31.1
	Female	88	88.6
Dahipale et al. [10]	Male	96	52.2
	Female	47	100.0
Hunnargi et al. [11]	Male	75	18.7
	Female	40	95.0
Present study	Male	75	19.17
	Female	40	95.02

## IV. Conclusion

The present study confirms that statistically significant sex differences were noted in sternal index; sex determination cannot be concluded finally from the sternal index in the population of Dhanbad district of Jharkhand, India. Hyrtl's law is not applied to the sternums confined to the population of Dhanbad. Sternal index for different population groups also varies. As our present study confirms that for various population groups the sternal index varies, hence we propose further studies on comparative samples may be insightful in confirming whether sternal index plays a role in determining the particular population or race.

### Conflict of Interest Declaration

The authors declare that there is no conflict of interest regarding the publication of this article.

### Acknowledgement

We gratefully acknowledge Department of Anatomy and forensic Medicine Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand, 826005 for providing research facilities to carry out this work.

### Ethical Approval

No ethical approval was required as the study was based on cadaver in the department of Anatomy and Forensic Medicine, Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand 826005

### References

- [1]. Soames RW. Section Ed. Skeletal system. In: Gray's anatomy- the anatomical basis of medicine and surgery. 38th ed. New York: ELBS with Churchill Livingstone; 1995. p. 433.
- [2]. Wenzel J. (1788), cited by Ashley GT. A comparison of human and anthropoid mesosterna. *Am J Phys Anthropol* 1956;14:449–65.
- [3]. Hyrtl J. (1878), cited by Dwight T. The sternum as an index of sex, height and age. *J Anat Physiol* 1881;15:327–30.
- [4]. Hunnargi SA, Menezes RG, Kanchan T, Lobo SW, Binu VS, Uysal S, et al. Sexual dimorphism of the human sternum in a Maharashtrian population of India: a morphometric analysis. *Leg Med (Tokyo)* 2008;10:6–10.
- [5]. Ashley GT. Typing of the human sternum: the influence of sex and age on its measurements. *J Forensic Med* 1956;3:27–43.
- [6]. Rentoul E, Smith H. Glaister's medical jurisprudence and toxicology. 13th ed. Edinburgh: Churchill Livingstone; 1973. 84–5.
- [7]. Narayan D, Varma H C. Sternal index in UP males and females. *J Anat Soc India* 1958;7:71–2.
- [8]. Jit I, Jhingan V, Kulkarni M. Sexing the human sternum. *Am J Phys Anthropol* 1980;53:217–24.
- [9]. Dahiphale VP, Baheete BH, Kamkhedkar SG. Sexing the human sternum in Marathwada region. *J Anat Soc India* 2002;51:162–7.
- [10]. Gautam RS, Shah GV, Jadav HR, Gohil BJ. The human sternum – as an index of age and sex. *J Anat Soc India* 2003;52:20–3.
- [11]. Dwight T. The sternum as an index of sex, height and age. *J Anat Physiol* 1881;15:327–30.
- [12]. Dwight T. The sternum as an index of sex, height and age. *J Anat Physiol* 1890;24:527–35.
- [13]. Hunnargi, S. A., Menezes, R. G., Kanchan, T., Lobo, S. W., Uysal, S., Herekar, N. G., Garg, R. K. (2009). Sternal index: Is it a reliable indicator of sex in the Maharashtrian population of India? *Journal of Forensic and Legal Medicine*, 16(2), 56–58. doi:10.1016/j.jflm.2008.08.004

Dr. Santosh Kumar, et. al. "Sternal Index Indicator of Sex in the Population of Dhanbad District of Jharkhand." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(08), 2021, pp. 01-04.