How to Cite:
Prasad, H., Parashar, R., & Jain, A. K. (2022). Changes in thoracic form morphology in healthy young adults to middle-aged people at numerous thoracic vertebral levels. *International Journal of Health Sciences*, *6*(S2), 11514–11524.
https://doi.org/10.53730/ijhs.v6nS2.8110

Changes in thoracic form morphology in healthy young adults to middle-aged people at numerous thoracic vertebral levels

Hari Prasad*
*Corresponding author

Dr. Rekha Parashar

Dr. Ashok Kumar Jain

***Abstract*---**Introduction- The Haller index is a thoracic breadth to height ratio. This was previously only at one unknown vertebral level in the thorax. Method- A total of 108 patients were enrolled. Measurements were taken in the axial plane picture at each vertebral level, beginning with T3 and ending with T12. The internal radiographic transverse and minimum anteroposterior diameters were measured using a CT machine and a GE PACS. Both diameters are measured so that they cross each other at a straight angle. Result: - 108 HRCT pictures were evaluated in total. The research included 73 males and 35 females. Patients range in age from 20 to 45 years. The male group's mean age was 38.89 years, with a standard deviation of ±6.11 years. The female group's mean age was 38.83 years, with a standard deviation of ±8.47 years. The overall mean (male + female) Haller index was 2.46 with a standard deviation of ±0.62. Males had a mean Haller index of 2.42 with a standard deviation of ±0.58. Females had to have a mean Haller index of 2.55 with a standard deviation of ±0.66. In men, the mean transverse diameter was 24.23 cm with a standard deviation of ±2.88 cm and the mean AP diameter was 10.63 cm with a standard deviation of ±2.93 cm. In females, the mean transverse diameter was 21.88 cm with a standard deviation of ±2.64 cm and the mean AP diameter was 9.15 cm with a standard deviation of ±2.48 cm. Conclusions: This study will offer quantitative measures on thoracic dimensions for future research by recording the mean Haller indices per vertebral level in both males and females aged 20 to 45 years in the non-deformed thorax.

***Keywords*---**pectus excavatum, pectus carinatum, haller index, scoliosis, COPD.

Manuscript submitted: 27 March 2022, Manuscript revised: 09 April 2022, Accepted for publication: 18 May 2022

Introduction

There are two types of growth patterns in the body: isometric growth and allometric development. Allometric growth is seen in foetuses, neonates, toddlers, and adults. True isometric development would require a time-dependent progressive proportionate increase in all organs and systems. Isometric growth clearly does not occur in developing embryos [1]. In humans, all portions of the body expand proportionally with time after birth. During the first year following birth, body length rises from 48–53 cm to 75 cm, then by 12 to 13 cm in the second year. Thereafter, 5 to 6 cm are added each year. In the individual longitudinal growth curve, an increase in the velocity of growth can be seen from 10.5 to 11 years in girls and 12.5 to 13 years in boys. Longitudinal studies have indicated that the average figure for this is 16.25 years for girls and 17.75 years for boys, with a normal variation of +/-2 years [2]. The transverse diameter is smaller at birth than it is in adulthood. As a person learns to walk, the proportion of transverse diameter rises. Females have a smaller thoracic capacity than males, both absolute and proportionally. The female sternum is shorter, resulting in a more slanted thoracic inlet. In females, the suprasternal notch is level with the third thoracic vertebra posteriorly [3]. Because the sternum is longer in men, the thoracic inlet is less sloped, and the suprasternal notch is level with the second thoracic vertebra posteriorly [2]. The size of the thoracic cage fluctuates continually in all people, depending on the motions of the ribs and diaphragm during breathing and the degree of abdominal visceral distension [3]. The thoracic cage increases proportionally in its anteroposterior, transverse, and vertical dimensions as a kid grows older. To this day, it is unknown how the thoracic cage grows in three dimensions. The common relationship between transverse diameter and anteroposterior diameter at the most proximal and most distal thoracic levels is unclear [4]. In North Indians, the relationship between transverse and anteroposterior diameter changes with age, and there is a dissimilarity between male and female genders. Furthermore, it is unclear how the relationship between these two dimensions varies with development spurts and behaves at maturity in North Indians. Haller et al [5] developed a technique for defining the relationship between transverse and anteroposterior dimensions in pectus excavatum patients in order to categories them as requiring surgical correction or non-interventional. They estimated the Haller index by diving transverse and minimum anteroposterior internal thoracic diameters measured from an axial CT thorax picture. This index was utilized as a decision-making aid for patients with pectus excavatum. The measurement was taken from an axial CT thorax slice at the greatest deformity level. The anteroposterior diameter was measured at the same position from the posterior surface of the sternum bone anteriorly to the anterior surface of the body of the thoracic vertebra posteriorly. The internal transverse and anteroposterior dimensions are measured in such a way that they cross at a straight angle, even if the sternum bone protrudes laterally with regard to the vertebral column. Land markings were usually considered to be skeletal rather than soft tissue atop the bones. The Haller index was established by Daunt et al. [6] for defining thoracic measurements for people who do not have a pectus excavatum thoracic abnormality. This time, each participant had one vertebral level measured, and the vertebral level was different in each person. In 2016, James E. Archer et al. [4] used Haller's methods to describe thoracic cavity dimensions in the British population. Is it applicable to other populations, such as north Indians, because it has been less investigated and studied in Indians? Height, weight, body mass index (BMI), sex, and various ethnicities all have their own unique genetic constitution and physical body composition. As a result, it is critical to undertake the study in order to estimate the likely pattern of growth ratio per-vertebral thoracic level with reference to age and sex in various geographically distributed human populations. The primary goal of this study is to determine and describe the shape of the thorax at each possible measurable vertebral level, beginning with thoracic vertebral level T3 and ending with thoracic vertebral level T12 in normal subjects without malformed chests over a range of ages in male and female genders.

Materials and Methods

Before beginning this investigation, IECs were obtained from Nims University in Rajasthan, Jaipur, and T. S. Misra Medical College & Hospital in Amausi, Lucknow. The research was carried out in collaboration with the Department of Anatomy at T. S. Misra Medical College and Hospital's Department of Radio-diagnosis. The research took place from February 2020 until January 2022. According to the revised diagnostic and treatment guidelines for Covid-19 patients, HRCT of the thorax was a significant diagnostic tool. A large number of CT thorax pictures of normal people were collected for the same purpose. The study included 108 normal patients who had good quality CT thorax scans. The age of normal patients in chosen CT thorax pictures ranged from 20 to 45 years old. The research group was formed using these CT scans.

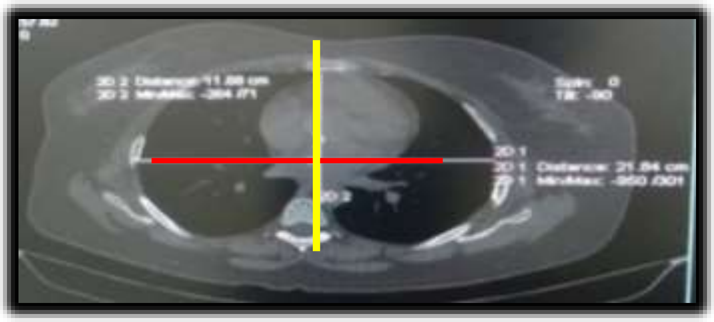

Figure No- 2.01. An axial image at vertebral level T7 of a 38-years female patient. Showing D1- transverse diameter 21.84cm and D2-anteroposterior diameter 11.68cm when measured digitally with PACS.

Using Haller's methodology, the chosen CT thorax pictures of each normal individual participant were measured from vertebrae T3 to T12. Because the top boundary of the jugular notch coincides with the intervertebral disc between thoracic vertebrae T2 and T3 posteriorly, and because there were no discernible bone land marks in the axial plane in an axial CT scan slice anteriorly. Measurement of the Haller index above incisura angularis was not possible. Transverse diameter measured transversely from right side to left side transversely. AP diameter measured between body of vertebra and sternum. The minimum anteroposterior diameter was measured from linea alba anteriorly to the anterior surfaces of the corresponding lower thoracic vertebrae in the caudal section of the thorax, below thoracic vertebral level T10. All measures were recorded by a single radiologist utilizing digital measurements from the Siemens CT machine's Picture Archiving Communication System (PACS). The data was evaluated for the Haller index at each measurable thoracic vertebral level. Both men and females were included, Patients under investigation ranged in age from 5 to 45 years old, both outdoor and indoor patients were also included. Patients with a history of chest trauma, Pregnant women, and Patients with a diagnosed instance of congenital thoracic abnormality were excluded from this study. The Haller Index is calculated using the following formula:

Haller index (HI) = Internal transverse diameter in cm / Antero-posterior diameter in cm

Results

The study includes 108 CT thorax pictures from patients. The patients in the research ranged in age from 20 to 45 years. There were 73 men and 35 women among the 108 patients. The P value with two tails is less than 0.0001. The male patients' mean age was 39.89 years, with a SD of ±6.11 years. Female patients had an average age of 33.83 years, with a SD of ±8.47 years. In male patients, the mean transverse diameter from T3 to T12 was 23.73, with a SD of ±2.88. In female patients, the mean transverse width from T3 to T12 was 21.38, with a SD of ±2.64. From T3 to T12, the mean anteroposterior diameter in male patients was 11.12 cm with a SD of ±2.93 cm (ten vertebral levels in each patient). The female patient's overall anteroposterior diameter was 9.89 cm with a SD of 2.49 cm. Males had a mean Haller index (HI) of 2.55 with a SD of ±0.50. In females, the mean Haller index (HI) was 2.57, with a SD of ±0.50. (Table.1,2,3 &4 Fig.1 &2)

S. N	Vertebral Level	Mean transverse diameter (cm)	Maxi/ Mini Variability (cm)	Mean AP diameter (cm)	Maxi/ Mini Variability (cm)
1	T3	18.88	22.45/12.50	6.12	7.83/4.27
2	T4	21.03	23.92/17.70	7.96	10.55/4.87
3	T5	22.21	25.29/19.64	9.50	12.2/6.14
4	T6	22.99	26.35/19.95	10.68	13.2/7.27
5	T7	23.61	27.28/19.75	11.61	14.44/7.57
6	T8	24.14	28.18/19.89	12.17	15.27/7.88
7	T9	24.92	29.09/19.82	12.42	15.91/7.72
8	T10	25.83	30.21/20.55	13.02	17.62/8.15
9	T11	26.62	30.53/21.42	13.78	18.05/8.79
10	T12	27.02	30.95/22.13	13.82	17.45/8.21

Table.1 The mean transverse and AP diameters, as well as the maximum and minimum variability per vertebral level, were measured in 73 male patients. The P value with two tails is less than.0001.

S. N	Vertebral Level	Mean transverse diameter (cm)	Maxi/ Mini Variability (cm)	Mean AP diameter (cm)	Maxi/ Mini Variability (cm)
1	T3	16.69	20.39/12.89	5.33	7.4/4.04

2	T4	19.00	22.40/16.6	7.27	9.76/5.14
3	T5	20.18	23.29/17.82	8.83	12.75/7.00
4	T6	20.92	24.17/18.56	9.81	12.96/7.23
5	T7	21.43	24.58/18.85	10.49	13.64/7.84
6	T8	21.78	24.58/19.15	10.78	13.81/7.84
7	T9	22.33	25.79/19.90	10.85	14.1/7.63
8	T10	23.18	26.99/20.30	11.48	14.72/8.04
9	T11	23.88	27.8/20.92	12.08	15.04/8.41
10	T12	24.45	28.26/21.76	12.06	16.14/9.02

Table.2 The mean transverse and AP diameters with greatest and minimum variability per vertebral level in 35 female cases. The two-tailed P value is smaller than.0001.

S.N	Vertebral level	Male		Female	
		Mean Haller Index (HI)	Maxi/Min	Mean Haller Index	Maxi/Mini Variability
1	T3	3.64	4.67/2.60	3.70	4.52/2.72
2	T4	3.17	4.06/2.43	3.18	3.69/2.44
3	T5	2.82	3.22/2.21	2.87	2.80/2.12
4	T6	2.68	3.06/2.09	2.66	2.90/2.14
5	T7	2.66	2.99/1.96	2.67	2.74/2.06
6	T8	2.52	3.10/1.99	2.55	2.75/2.04
7	T9	2.55	3.26/2.05	2.59	2.94/2.02
8	T10	2.54	3.14/2.04	2.55	2.81/2.00
9	T11	2.48	3.07/1.99	2.51	2.63/2.00
10	T12	2.50	2.97/1.98	2.56	2.75/2.10

Table-3 Comparison of male and female mean Haller indices with greatest and least variability per vertebral level.

Vertebral level	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Male	3.64	3.17	2.82	2.66	2.66	2.52	2.55	2.54	2.48	2.50
SD	0.51	0.39	0.32	0.28	0.28	0.30	0.33	0.35	0.32	0.33
Female	3.70	3.18	2.87	2.68	2.67	2.55	2.59	2.55	2.51	2.56
SD	0.58	0.44	0.34	0.29	0.26	0.28	0.32	0.30	0.29	0.29

Table. 4 Comparison of mean Haller indices at different vertebral levels in male and female patients.

Table.4 showing T3 has the highest mean Haller index in males. It declines from T3 to T8, then slightly increases at T9, then drops again at T10 and T11, and finally increases again at T12. T3 was shown to have the highest Haller index among females. It declines from T3 to T8. T9 shows a little rise, T10 and T11 show a drop, and T12 shows an increase. Females had higher Haller indices per vertebral level than males.

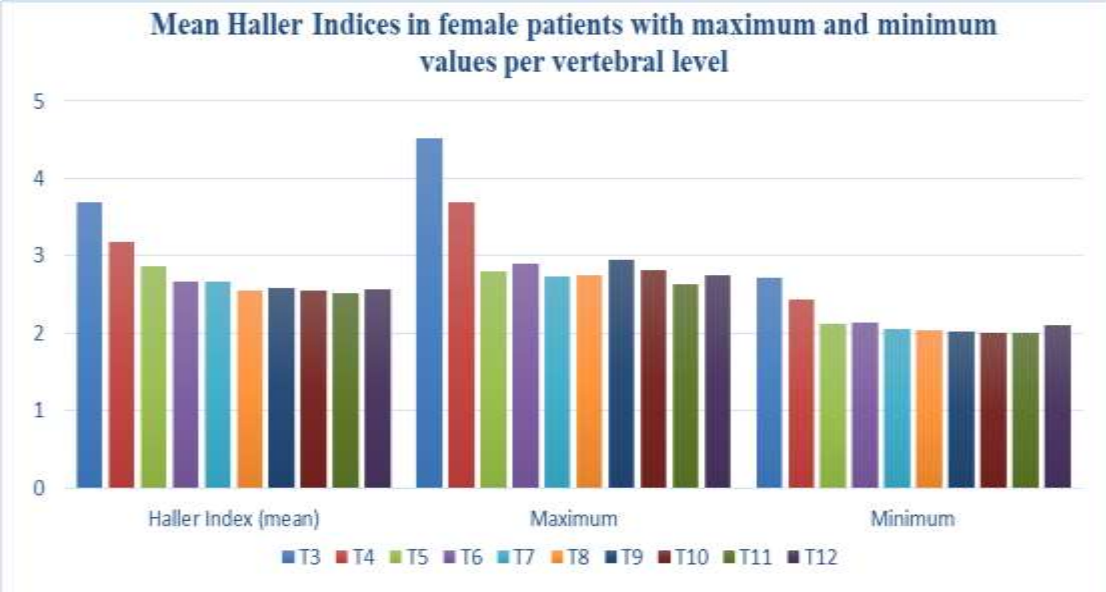

Fig.1 Represents vertebral level on X-axis, and mean Haller indices with maximum and minimum Haller indices on Y-axis at 95% confidence interval.

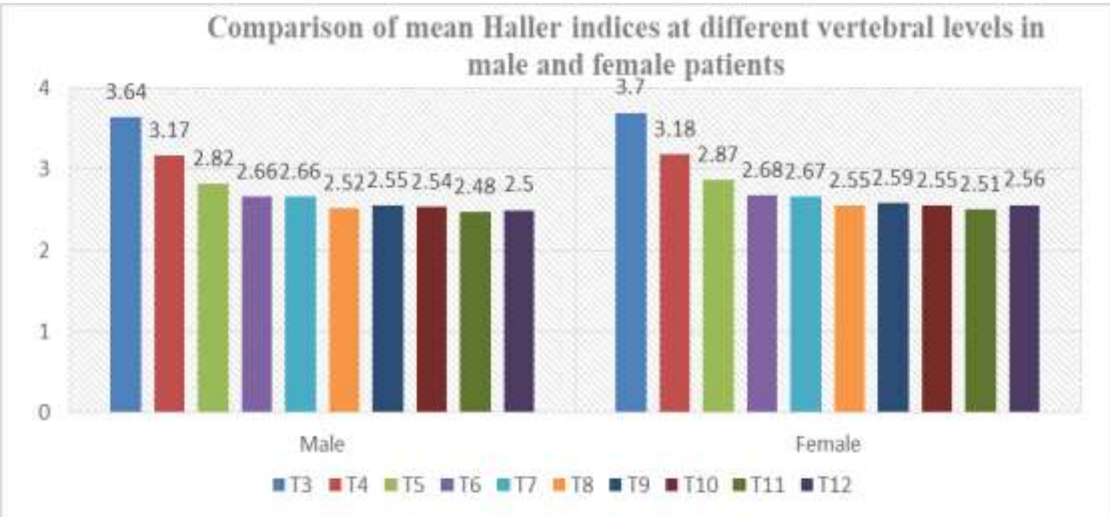

Fig.2 Comparison of mean Haller indices at different vertebral levels in male and female patients at 95% confidence interval

Discussions

In humans, the thoracic cage is a complex three-dimensional osseocartilaginous armature. Its structure represents intrathoracic important organs such as the lungs and heart. The thoracic cage protects important organs while also providing attachments for extrinsic and intrinsic muscles. These muscles either directly or indirectly aid in the breathing process, which is required for survival. The rostral end of the thoracic cage is produced by higher ribs forming a rim below the thoracic inlet, which contributes to the ribs' downward slope [4]. It might be argued that it is not a real thorax [4]. Because it is thin above and continuous to the base of the neck, the thorax resembles a truncated cone. While the distal end of the thorax is broader, it creates the thoracic outlet, which is separated from the abdominal cavity by the diaphragm, a musculotendinous sheet of muscle. The thorax is flattened dorsoventrally and convex laterally. The results (Table.1 & 2) showing that mean transverse and anteroposterior dimensions were the shortest at T3. Furthermore, there was a consistent decrease at each subsequent vertebral level up to T12. Both diameters were at their greatest at T12. A similar trend was noticed in maximum and minimum variable values for both diameters tested, omitting mean values. This fact strongly favors a tapering upper end and a wider lower end near the outlet. Further, transverse diameter is less in infancy, but it begins to rise when the individual learns to walk [3]. Transverse diameter reaches its maximum in adulthood [3]. the maximal magnitude of transverse diameter, as well as the convexity and curvature of the ribs, the thorax is convex laterally [7]. because the anteroposterior diameter is more than three times smaller than the transverse diameter at T3. Anteroposterior diameter was found to be almost twice as small at each subsequent measured vertebral level. This fact demonstrates a dorsoventrally flattened shape. The sternum forms the anterior boundary of the thoracic inlet at T3. The muscles of the anterior abdominal wall create the anterior boundary of the thorax below the distal end of the sternum. On examination of a 3-D reconstructed thoracic cage from the lateral side between T1 and T12, the anterior border in the mid line is formed by the cranial and caudal ends of the sternum anteriorly, revealing that the posterior border, which is formed by the thoracic segment of the vertebral column, appears longer than the anterior border, it is also longer in reality (see fig. no 2.04). In certain cases, we did a 3-D reconstruction of a few thoracic cage photos. We discovered an intriguing example in which the anterior end of the right 4th rib was bifurcated. A bifid rib is a congenital abnormality in which the sternal end is split in two. It might be unilateral or bilateral in nature. In populations, the prevalence of bifid ribs ranges from 0.15 percent to 3.4 percent [8]. of the ribs accounts for up to 20% of all congenital rib anomalies [8]. Gorlin - Goltz syndrome can be distinguished by a bifid rib [9]. Physicians, surgeons, and radiologists are all concerned about rib bifidity.

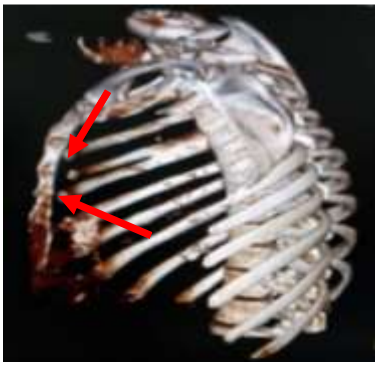

Figure No- 2.04 - Left lateral view, 3-D CT reconstructed image of a 38 years old female showing bifurcated anterior end of right 4th rib.

Cut left side upper ribs for visualization

The thorax begins at T3 vertebral level below the thoracic inlet when the CT thorax picture is viewed in an axial plane. There is no consistent and recognizable bone land mark anteriorly above T3 in the axial picture. The sternum forms the anterior edge of the thorax from T3 to T10. The rectus abdominis muscle forms the anterior boundary of the thorax below the distal end of the sternum (T10), and the linea alba, which forms the midline, is produced by the decussating fibres of the aponeuroses of the flat muscles of the anterior abdominal wall. The Haller index, created and developed by Haller et al. [5]. This index was created by dividing the highest internal transverse thoracic diameter by the lowest anteroposterior diameter as assessed on an axial CT thorax picture. This metric was used to evaluate pectus excavatum. This index was calculated and measured at a single vertebral level per subject. As a result, the vertebral level was not fixed and referenced. Despite the fact that Haller et al. estimated the mean index from a small sample size of 2.56 without chest deformity in their initial paper. Daunt et al. [6] later analyzed a large number of CT thorax pictures in children aged 0 to 18 years' old who did not have chest deformity. They utilized the vertebral level in the chest to determine which had given the highest value to the Haller index, which was not always the same. This study indicated that the normal value was lower than that determined in Haller's initial study (2.56). This study (Daunt et al.) discovered that the Haller index was age dependent. As a normal individual develops, the Haller index changes. J E. Archer et al. used a large number of CT images of normal individuals ranging in age from 8 to 18 years in their research. The vertebral levels of measurement of the Haller index were fixed and referred to in this investigation (T3 to T12). It was stressed that a single mean Haller index value is insufficient. At each vertebral level, the Haller index acts differently. The maximum value of the Haller index was discovered at T3, with subsequent decreases up to T8 and T9, followed by higher values at T10, T11, and T12 in both sexes. As both sexes get older, the Haller index rises, especially in the more cranial thorax and, to a lesser extent, the more caudal thorax. As the influence of age was studied, it is discovered that Mean Haller Indices increases with adulthood to middle age on average in 88.2 percent of instances, when compared to 20 years of age at the spinal T3 level. This indicates that at the T3 level, anteroposterior diameter decreases with age. Age is positively related to age. When compared to 20 years of age, the Haller index is greater in 94 percent of instances at the T4 level, although there is no regular pattern. The same is true at the T5 level. Haller indices were greater at the T6 level in 76.47 percent of patients. In 70.58 percent of instances, Haller indices were greater at the T7 and T8 levels. In 52.94 percent of instances, the Haller indices were higher. When compared to 20 years of age, Haller indices were greater or equivalent at the T10 level in 52.82 percent of patients. At T11 and T12 levels, a separate and reversal trend was seen. Haller indices reveal a drop of 64.70 percent at T11 and 82.35 percent at T12. This suggests that the upper and lower thorax shapes differ in middle-aged persons The current study is unique in that assessment of the Haller index at several (T3 to T12) vertebral levels in a CT thorax picture is seldom examined in the north Indian population. Second, this study is being undertaken to record the Haller index in adult to middle-aged (20 to 45-year-old) North Indian males and girls. The Haller index is highest in both males and females at the first detectable vertebral level, T3. This observation is consistent with that of JE Archer et al. From T3 through T8, the Haller index falls, then rises somewhat at T9, falls again at T10 and T11, and rises again at T12. At T8 and T11, men and women have the lowest Haller index values. This finding differs from that of JE Archer et al. It is also obvious that females have greater Haller indices per vertebral level than males. One intriguing aspect is that the difference between mean Haller indices in adult to middle-aged males and females is not statistically significant per vertebral level. Previously, differences were important because, as people age, their growth rates and spine curvature change. In adults and middle-aged people, the Haller index relates to the curvature of the spine, which can vary depending on the thickness (height) of the intervertebral disc. The results of present study are of relevance because this is first time description of effect of age on shape of thorax in adult to middle aged north Indians. This documentation of normative data can be used for further research. Clinical significance is related to surgical treatment and management of pectus excavaum, pectus carinatum and scoliotic left undiagnosed middle-aged patients. Now a day's pectus excavatum is treated invariably using minimally invasive procedure with a Nuss [10] bar in teens and young adults. Pectus carinatum is corrected by surgical procedure Ravitch surgery [11, 12]. Scoliosis is an abnormal sideways curvature of spine with rotation of thoracic cage and development of a rib hump [13]. Current surgical technique is to correct curvature of spine and rotation of thoracic cage [14]. Therefore, it is critically important for corrective and reconstructive surgeons to know what is 'normal' in surgical technique. Where surgeon intends to return the patients to 'normal'. The Haller index measurement, as a quantification, is not without issues. There is evidence that there are differences within the Haller index. Many factors can influence the quality of CT thorax images obtained, such as the amount of inspiratory and expiratory phases of breathing [15, 16]. Under this investigation, there is no reason to suspect because CT pictures are always acquired in maximal inspiration and breath-holding conditions in usual practice. This study measures the average Haller index per vertebral level from T3 to T12 in healthy young people and middle-aged patients. This pool of data, which includes men and women aged 20 to 45 years, provides a record of non-deformed thoracic normative data. This information will aid in making decisions on distorted thoracic cage dimensions in patients with chronic obstructive pulmonary disease. As the majority of COPD patients are in their forties and fifties. It will be of enormous service in the current period, when scientists are attempting lung translations in patients with severe COPD [17].

Conclusion

This study will offer normative data on thoracic dimensions for future research by recording the mean Haller indices per vertebral level in both males and females aged 20 to 45 years in the non-deformed thorax. Specifically, people with COPD or obstructive lung disorders such as asthma and bronchiectasis had their chests distorted. Since the majority of COPD patients are in their forties and fifties. It will also aid in the identification of individuals with undetected pectus excavatum, pectus carinatum, and scoliosis.

Acknowledgments

The authors would like to thank HOD anatomy department from Nims University Rajasthan Jaipur, for providing all possible support and for permitting me to conduct this study. I acknowledge the subject who participated in this study

Funding: Nil
Conflict Of Interest: Nil
Ethical approval: The study was approved by the Institutional Ethics Committee of NIMS University Rajasthan Jaipur

References

1. Henary Gray edited by Peter L. Williams. The Anatomical basis of medicine and surgery. Churchil Living Stone; 1995, 38 editions, chap 4, p. 366.
2. Harrison G A, Weiner J S, Tanner J M, Barnicot NA. Human biology. Clarendon press: Oxford, 1964, chap 19.
3. Henary Gray edited by Susan Standring. The Anatomical basis of clinical practice. Elsevier limited; 2016, 41 editions, Chap 51, p. 545-46.
4. James E. Archer, Adrian G., Fiona B. and Paul P. The measurement of the normal thorax using the Haller index methodology at multiple vertebral levels. J Anat., 2016; V 229, p 577- 581.
5. Haller J, Kramer S, Leitman S (1987) Use of CT scans in selection of patients for pectus excavatum surgery: a preliminary report J Pediatr Surg 22, 904–906.
6. Daunt S, Cohen J, Miller S(2004) Age-related normal ranges for the Haller index in children..Pediatr Radiol34, 326–330.
7. Henary Gray edited by Peter L. Williams. The Anatomical basis of medicine and surgery. Churchil Living Stone; 1995, 38 editions, p. 537.
8. E. Kupeli, G.Ulubay. Bony Bridge of a bifid rib. Cleveland Clinic Journal of Medicine, vol 77, pp. 4232-233, 2010.
9. J. A. Geel, K. G. Bennett, J. M. Rigby, J. E. Poole. Gorlin syndrome. SA Journal of Child Health, vol 5, no.1, pp.21-22, Mar, 2011.
10. Nuss D, Kelly R Jr, Croitoru D(1998) A 10-year review of a minimally invasive technique for the correction of pectus excavatum.J Paediatr Surg33, 545–552.
11. Pilegaard H(2015) Nuss technique in pectus excavatum: a monoinstitutional experience.J Thorac Dis7(Suppl 2), S172–S176.
12. RAVITCH MM. Unusual sternal deformity with cardiac symptoms operative correction. J Thorac Surg. 1952 Feb;23(2):138-44.
13. Kálmán A. Initial results with minimally invasive repair of pectus carinatum. J Thorac Cardiovasc Surg. 2009 Aug;138(2):434-8.
14. Hong J-Y, Suh S-W, Easwar T, et al.(2011) Evaluation of the three-dimensional deformities in scoliosis surgery with computed tomography: efficacy and relationship with clinical outcomes.Spine36, E1259–E1265.
15. FA: Mohammed, R. A., Saifaddin, A. L., Mahmood, H. F., & Habibi, N. (2022). Seismic Performance of I-shaped Beam-column Joint with Cubical and Triangular Slit Dampers Based on Finite Element Analysis. Journal of Studies in Science and Engineering, 2(1), 17-31.
16. FA: Hersh F. Mahmood, Hooshang Dabbagh, Azad A. Mohammed, Comparative study on using chemical and natural admixtures (grape and mulberry extracts) for concrete, Case Studies in Construction Materials, Volume 15, 2021,

17. Kumar, S. (2022). A quest for sustainium (sustainability Premium): review of sustainable bonds. Academy of Accounting and Financial Studies Journal, Vol. 26, no.2, pp. 1-18
18. Allugunti, V.R. (2019). Diabetes Kaggle Dataset Adequacy Scrutiny using Factor Exploration and Correlation. International Journal of Recent Technology and Engineering, Volume-8, Issue-1S4, pp 1105-1110.
19. Albertal M, Vallejos J, Bellia G, et al. (2013) Changes in chest compression indexes with breathing underestimate surgical candidacy in patients with pectus excavatum: a compute tomography pilot study.J Pediatr Surg48, 2011–2016.
20. Birkemeier K, Podberesky D, Salisbury S, et al. (2011) Breathe in… breathe out…stop breathing: does phase of respiration affect the Haller index in patients with pectus excavatum? AJR Am J Roentgenol197, W934–W939.
21. Kasper DL, Fauci AS, Hauser S, et al, editors. Harrison`s Principle of Internal Medicine. Mc Graw Hill Education; 2018, 20 editions, pages1997.