

***SEX ESTIMATION BASED ON MAXILLARY SINUS DIMENSION MEASUREMENTS
USING COMPUTED TOMOGRAPHY (CT) SCAN OF PARANASAL SINUS***

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ABSTRAK

Estimasi jenis kelamin merupakan langkah yang sangat penting dalam upaya identifikasi kasus forensik. Identifikasi personal akan mendapat hasil akurat jika didapatkan 100% keseluruhan rangka, namun hal ini tidak dapat dilakukan pada kasus kekerasan berat dan bencana alam. Oleh karena itu, dibutuhkan parameter identifikasi yang tidak mudah rusak dan sering ditemukan dalam keadaan utuh seperti sinus maksilaris yang melalui penelitian ini bertujuan untuk mengetahui perbedaan dimensi volume sinus maksilaris pada pria dan wanita. Penelitian observasional analitik dengan rancangan *Cross Sectional* ini menggunakan total 33 sampel hasil *CT scan* Sinus paranasal dari 17 pria dan 16 wanita di Departemen radiologi RS Islam Sultan Agung Semarang periode Januari – Desember 2024 yang memenuhi kriteria inklusi dan eksklusi. Hasil analisis menunjukkan terdapat perbedaan yang signifikan volume sinus maksilaris pada pria dan wanita, didapatkan nilai $p = 0.003$, dengan rerata volume sinus maksilaris pada pria adalah 20.67 cm^3 dan dimensi volume sinus maksilaris pada wanita adalah 16.7 cm^3 . Berdasarkan hasil tersebut disimpulkan bahwa terdapat perbedaan signifikan antara sinus maksilaris pria dan wanita.

Kata kunci: *Estimasi jenis kelamin, dimensi volume sinus maksilaris*

ABSTRACT

Sex estimation is a very important step in forensic identification. Personal identification will be accurate if 100% of the entire skeleton is obtain, but it cannot be done in several cases such as severe violence and mass disasters. Therefore, an identification parameters that are not easily damaged and are often intact is required, such as the maxillary sinus, which through this study aims is to determine the difference in volume of the maxillary sinus in male and female. This study is an observational study with cross sectional design used a total of 33 samples of Paranasal sinus from 17 men and 16 female in the radiology department of Sultan Agung Islamic Hospital Semarang for the period January – December 2024 who met the inclusion and exclusion criteria. The analysis showed that there are significant difference in there was a significant difference in the volume of the maxillary sinus in men and female, with a value of $p = 0.003$, with the average volume of the maxillary sinus in men being 20.67 cm^3 and the dimension of the volume of the maxillary sinus in female being 16.7 cm^3 . Based on these results, it was concluded that there was a significant difference between male and female maxillary sinuses.

Keywords: Sex estimation, maxillary sinus volume dimension

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INTRODUCTION

Geologically and geographically, Indonesia has a high risk of disaster because it is located at the confluence of four main plates, namely Indo Australia, Eurasia, the Philippines and the Pacific¹. *Badan Nasional Penanggulangan Bencana* reported that throughout 2022 there were 3,531 disaster events both caused by natural, non-natural and human factors. The victims caused by natural disasters are 851 people died, 46 people are missing and 8,726 people are injured. One of the major disasters that has ever occurred in Indonesia is the Lion Air JT610 plane crash where in the accident of 189 victims, as many as 64 victims were not identified. Based on *Peraturan Pemerintah No. 36 tahun 2009* regarding health, giving orders to the government and communities to carry out efforts to identify disaster victims². The purpose of identifying the deceased victim legally is intended to fulfill human rights so that their identities can be known so it can be returned to their families and buried properly according to their religion during their lives³.

Sex identification is crucial in determining identity because it can reduce the possibility by half⁴. Parameters that are often used in determining gender include skull bones, pelvic bones, foramen magnum, mandibles, long bones, teeth and several other characteristics⁵. In the event of natural disasters, often the bodies found are already in a damaged or decomposing condition so that the identification method using the parameters mentioned above cannot be done⁶, therefore other parameters are needed for sex estimation. The maxillary sinus is a strong structure and often remains intact even when bones and other structures are severely damaged, making the maxillary sinus useful for the investigation of sex-related characteristics⁷.

The maxillary sinus is the largest paranasal sinus and fills the *corpus maxillae*⁸. The maxillary sinus is pyramidal-shaped with apex leading laterally and at the base in the profunda of the adjacent lateral wall of the nasal cavity^{9,10}. Its medial wall is formed by the maxilla, and by the inferior nasalis concha part *os. Palatinum* which is above the hiatus maxillaris. The sinus opening is near the apex of the base, inside the center of the semilunar hiatus, which creates a channel on the lateral wall of the riceus media^{8,11,12}. Based on the consideration of complex sinus structures, *computed tomography* is the gold standard used to visualize the anatomy of the sinuses¹³.

MATERIAL AND METHODS

Material

This current study on the colleration between the dimension of maxillary sinus volume and sex estimation was carried out at the Department of Radiology of the Sultan Agung Islamic Hospital, Semarang using the results CT Scan of the paranasal sinuses patients.

Data Acquisition

This current study on the colleration between the dimension of maxillary sinus volume and sex estimation was carried out at the Department of Radiology of the Sultan Agung Islamic Hospital, Semarang using the results CT Scan of the paranasal sinuses patients for the period January – December 2024. Based on patient data collection using the total sampling method, 43 were obtained who performed *SPN CT Scan* examinations and 33 samples were obtained that met the inclusion and exclusion criteria.

This study included 20 – 40 years old patients with the right and left maxillary sinus cavities well divined and without any pathology. The dimension of the maxillary sinus volume were meassured manually by radiologists.

1. Maxillary sinus height was measured on sagittal projection by measuring the maximum diameter of the right and left sinus craniocaudals.
2. Maxillary sinus depth was measured on coronal projection by measuring the maximum diameter of the right and left sinus anteroposteriors.
3. The maxillary sine width was measured on the coronal projection by measuring the maximum width of the right and left sine.

The volume of the maxillary sinus was calculated using the following equation

$$\text{Volume} = (\text{height} \times \text{depth} \times \text{width} \times 0.5)$$

After measuring maxillary volume stastical analysis was performed by independent sample t test.

RESULTS

After the calculation of the results obtained, a normality test was carried out using the Kolmogorov Smirnov test. The test results showed that all groups of normally distributed data had a $p > \text{value of } 0.05$ (Table 1).

Table 1. Normality Test

	Male			Female		
	<i>p</i> value	Mean	Distribution	<i>p</i> value	Mean	Distribution
Volume	0.12	20.67 cm ³	Normal	0.12	16.7 cm ³	Normal

The mean values of the maxillary sinus for males was 20.67 cm³ and for females it was 16.7 cm³ (Figure 1). The results of the independent t-test test on the volume of the maxillary sinus and sex showed a value of $p = 0.003$ where the value was less than 0.05. This shows that there was a significant difference in the dimensions of maxillary sinus volume in male and female.



Figure 1. Difference in mean of the maxillary sinus in male and female

DISCUSSION

This study showed that the average volume of maxillary sinuses in men was 20.67 cm³. This was much larger than the average volume of the maxillary sinuses in female, which was 16.7 cm³. This is in line with previous research by Wuu, *et al* which showed an average maxillary sinus volume was 19.78 cm³ in male and 15.55 cm³ in female. Similar research by Raduleco, *et al* also obtained the results of measuring the volume of the maxillary sinus in men was 16.73 cm³ and the volume of the maxillary sinus in female was 12.48 cm³.

This shows that there is a significant difference in volume between male and women according to Kanthem, *et al* the accuracy rate is 79%¹⁴. In addition, studies conducted in Europe show that the maxillary sinuses of male are larger in dimensions than female¹⁵.

In 2013 Vidya, *et al* conducted a study on 30 dry skull bones originating from India by measuring the height, length, width and volume of the maxillary sinuses on each side. The results showed that the measurement and volume of the maxillary sinuses were slightly larger compared to that of female.

Study Limitations

The study had limitations regarding the number of samples, so the results obtained may not be fully representative of the larger population. In addition, this study only uses the *CT Scan* of the paranasal sinuses and still uses manual volume measurement.

CONCLUSION

There was a difference in the dimensions of the maxillary sinuses measured using *Computed Tomography (CT) scans* of the Paranasal Sinuses in men and female with the average dimensions of the maxillary sinuses in male being 20.67 cm³ and the average dimensions of the maxillary sinuses in women being 16.7 cm³.

REFERENCES

1. Yulianto, S. *et al*. Histori Bencana dan Penanggulangannya di Indonesia Ditinjau Dari Perspektif Keamanan Nasional. *PENDIPA Journal of Science Education* **5**, 180–187 (2021).
2. Ismail, T. S. & Syarifudin, K. B. Disaster Victim Identification (DVI) Training For Medical Student. *Jurnal Pendidikan Kedokteran Indonesia: The Indonesian Journal of Medical Education* **9**, 95 (2020).
3. Idries, A. M. *Buku Penerapan Ilmu Kedokteran Forensik*. (2008).
4. Shepherd, R. *Simpson's Forensic Medicine*. (2019).
5. Milella, M., Franklin, D., Belcastro, M. G. & Cardini, A. Sexual differences in human cranial morphology: Is one sex more variable or one region more dimorphic? *Anat Rec* **304**, 2789–2810 (2021).
6. Mello-Gentil, T. & Souza-Mello, V. Contributions of anatomy to forensic sex estimation: focus on head and neck bones. *Forensic Sci Res* **7**, 11–23 (2022).
7. Baca, K., Bridge, B. & Snow, M. Three-dimensional geometric morphometric sex determination of the whole and modeled fragmentary human pubic bone. *PLoS One* **17**, e0265754 (2022).
8. Iwanaga, J. *et al*. Clinical anatomy of the maxillary sinus: application to sinus floor augmentation. *Anat Cell Biol* **52**, 17 (2019).

9. Nada Nabilah, Agustina Dwi Prastanti & Darmini. Prosedur Pemeriksaan Radiografi Sinus Paranasal (SPN) Dengan Kasus Sinusitis. *Jurnal Radiografer Indonesia* (2023).
10. Whyte, A. & Boeddinghaus, R. The maxillary sinus: physiology, development and imaging anatomy. *Dentomaxillofacial Radiology* **48**, 20190205 (2019).
11. Richard L. Drake, Wayne Vogl & Adam W. M. Mitchell. *Gray's Basic Anatomy, 3rd Edition*. (2012).
12. Niekrash, C. E. Anatomy of the Nose and Paranasal Sinuses. in *Applied Head and Neck Anatomy for the Facial Cosmetic Surgeon* 79–84 (Springer International Publishing, Cham, 2021). doi:10.1007/978-3-030-57931-9_9.
13. Fatterpekar, G. M., Delman, B. N. & Som, P. M. Imaging the Paranasal Sinuses: Where We Are and Where We Are Going. *Anat Rec* **291**, 1564–1572 (2008).
14. Kanthem, R., Guttikonda, V., Yeluri, S. & Kumari, G. Sex determination using maxillary sinus. *J Forensic Dent Sci* **7**, 163 (2015).
15. Jeon, E.-Y., Ahn, H.-N. & Park, J.-T. Sex Determination through 3D Analysis of the Maxillary Sinus. *Iran J Public Health* (2022) doi:10.18502/ijph.v51i6.9702.

APPENDICES

JENIS KELAMIN	PANJANG	LEBAR	TINGGI	VOLUME
P	42,3	22	34,5	16053
P	40,3	23,7	32,6	15568
P	43	24,3	40,1	20950
P	38,1	27,2	35,6	18446
P	36	25	35,8	16110
P	43,5	21	38,3	17494
P	35,3	20,5	34,9	12628
P	43,3	20,5	34	15090
P	41,6	21	34	14851
P	50	25,4	39,9	25337
P	40,7	22,4	37,2	16957
P	37	25,2	35	16317
P	35,5	23	34	13881
P	41,5	25,5	36,4	19260
P	38,6	23,2	34	15224
P	37,5	26,2	33,9	16653
	40,2625	23,50625	35,6375	16,92

Appendix 1: Maxillary volume measurements'

JENIS KELAMIN	PANJANG	LEBAR	TINGGI	VOLUME
L	44,3	25	37,2	20600
L	40	27,7	39,1	21661
L	43,5	26	37,9	21432
L	42	27	41	23247
L	41,05	27,6	41	23226
L	45,8	22,2	37,2	18912
L	40,2	21,8	35,1	15380
L	42,8	22,2	37,2	17673
L	44,5	32,3	40,6	29178
L	38,4	23	36,3	16030
L	37,8	25,7	36,8	17875
L	40,1	27	37	20030
L	40	26,4	33,9	17899
L	41,6	28,2	36	21116
L	40,5	29,5	39	23298
L	44,7	24	34	18238
	41,70313	25,975	37,45625	20,67

Appendix 2: SPSS Output

a. Normality test

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Volume Sinus Maksilaris	.137	33	.123	.915	33	.014

a. Lilliefors Significance Correction

b. Independent sample t test

Independent Samples Test									
		Levene's Test for Equality of Variances			t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
Volume Sinus Maksilaris	Equal variances assumed	.731	.399	3.250	31	.003	3731.695	1148.359	1389.601 4073.789
	Equal variances not assumed			3.260	30.793	.003	3731.695	1142.798	1400.119 4063.271