



## VARIABILITY OF ANATOMICAL FEATURES OF FRONTAL SINUSES AMONG THE MALE ETHNIC GROUPS RESIDING IN KARACHI.

Quratulain Javaid<sup>1</sup>, Ambreen Usmani<sup>2</sup>

1. MBBS, PGD-Bioethics  
Senior Lecturer Anatomy  
Bahria University Medical and  
Dental College.
2. MBBS, M.Phil (Anatomy), MCPS-  
HPE,  
PGD-Bioethics, PhD-Anatomy  
Professor and HOD Anatomy  
Bahria University Medical and  
Dental College.

**Correspondence Address:**

Dr. Quratulain Javaid  
Anatomy Department  
1<sup>st</sup> floor Sailor Street,  
Adjacent PNS-SHIFA D.H.A. Phase 2  
Karachi.  
coolwater480@gmail.com

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**ABSTRACT... Objectives:** To determine anatomical variability in morphometry of frontal air sinuses in male ethnic groups residing in Karachi. **Study Design:** Cross sectional descriptive study. **Setting:** Radiology Department of Jinnah Postgraduate Medical Center. **Period:** Nov 2018 to April 2019. **Material & Methods:** In total, the research subjects were 108. They were divided into four ethnic sub groups. Each ethnic subgroup had 27 members. The study subjects were in between 20 to 50 years of age with the mean age of  $35.14 \pm 8.68$  years. Before the enrolment of the participants in the research, informed consent was taken. The methodology incorporated was X-ray radiography. The view for radiology was Water's view. Area, height and width of both right and left frontal sinuses were measured by the help of Radiant DICOM digital software. A questionnaire was designed to record the demographic data. The parameters of area, height and width of the sinuses were noted in the proforma. The data was analyzed by the help of SPSS version 23.0. **Results:** The ethnic sub groups were compared by the application of One Way ANOVA. The comparison of the four ethnic groups showed high variability in terms of area, height and width of the right frontal air sinuses ( $p=0.000$ ). Significant variations were also recorded for these parameters on the left side ( $p=0.000$ ). **Conclusion:** The height width and area show pattern of anatomical variability in the right and left frontal air sinuses among the ethnic groups of males living in Karachi.

**Key words:** Anatomy, Ethnicity, Forensic Science, Frontal Sinus.

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### INTRODUCTION

People living in the society possess different identities. They are known by their individual identifications. The proof of the human identity is vital and needs to be documented. The identification is important for the living individuals as well as for the deceased. The data that records the identification documentation is imperative for several reasons. On a broader scale, these include social and legal causes. Social causes include identification for the purpose of citizenship, employment, census etc. The legal purpose of documentation is required in medicolegal cases, heirship etc. The documentation requires a systematic procedure to be followed. Identification can be done with authenticity by looking at the facial features and appearances. In circumstances of disasters, facial features are difficult to recognize. In this age and period of time, the numbers of reported

incidents of the catastrophes are escalating. The ones associated with nature include hurricanes, earthquake, tornadoes etc. The humans' oriented disasters include railway and airplane crashes, mass explosions, nuclear attacks etc. Whatever the reason be, identification of the human remains become an extremely difficult task in such adversities.<sup>1,2</sup> A published report summated the record of violence and terrorist acts in Pakistan. According to the report, number of incidences of tragic violence and mass explosions are on a rise from the year 2011 to the year 2015.<sup>3</sup>

In order to establish the identity of the unknown persons the anatomists and the forensic experts have adopted several methods.<sup>4</sup> The expertise in identification of the disfigured bodies is possible by continuous research, adoption of newer methods and interpretation of the available data. The identification of the bodies can be

accomplished on the basis of unique framework of the structures present in the human body. The distinctive characteristics of the body structures serve as a cornerstone for the identification of the unknown deceased. It is mandatory to have before death record of the deceased so that the post mortem sample can be compared and then matched with that of the antemortem sample.<sup>5</sup> There are several types of methodologies incorporated these days out of which soft tissue analysis and DNA examination are amongst the commonly used and dependable methods. The soft tissue analysis involves use of finger printing and lip printing. The DNA analysis is a biochemical method of knowing the identity of the dead bodies. It is imperative for the DNA analysis procedure to have the availability of a sample that is of good quality. The variation and extremes of climate can interfere with the sample composition. A research has documented that excessive heat can interfere with the chemical composition of the sample and therefore it does not stay suitable and appropriate for the procedure of amplification of DNA and thus PCR cannot be carried out. In such circumstances faulty interpretations can lead to misleading reports and results.<sup>6,7,8</sup>

The incidences of mass explosion result in disfigurement of the bodies that lead to mutilation and putrefaction. In the skeletonized bodies, soft tissues are not present and therefore soft tissue sampling does not remain a possible method of identification. Although DNA examination and analysis can be done even when the soft tissues are lost but the available hard part has to be in appropriate and suitable state.<sup>9,10</sup>

The method that can be used with authenticity in cases when there are present putrefied and decomposed human remains is radiography of the bony structures. The radiological methods are based on the presence of uniqueness of the bones present in the body. The identification of the unknown person depends on the individuality and specificity of the structure of the bone that remains unique to every person. The radiography is not only simple to carry out but also the technology involved is easily comprehended and can be applied in situations when there are lack

of personal expertise as well as when the required resources are scanty.<sup>11,12</sup>

The importance and significance of skull for the purpose of personal recognition cannot be denied and thus the approach of employing skull as a tool in personal identification is being used by the anthropologists. Skull is a bony structure that is formed by the combination of 22 bones. It is the part of the axial skeleton of the body.<sup>13</sup> It has been documented that skulls are preferred for identification because of the presence of certain features that are distinctive to every individual. Other than the unique characteristic features, the ability of the skull to with stand trauma even in mass explosions make it an excellent tool for forensic identification.<sup>14</sup> The regions that are commonly used for identification purpose within the skull include paranasal sinuses, mastoid process and teeth.<sup>15</sup>

Within the skull, paranasal sinuses are one of the most commonly used regions for identification of the unknown bodies.<sup>15</sup> Out of the four paranasal sinuses, the structure that is most commonly used for individualization purpose is the frontal sinus. Frontal sinus is known for its forensic importance. The anatomy of frontal sinus is exclusive to every person just like the finger prints. Frontal sinuses have characteristic features that are unique to every individual. They are two in number. The frontal sinuses and are located within the frontal bone, above the region of orbit behind the area of superciliary arches. The two frontal sinuses are separated by a inter sinus septum.<sup>13</sup>

There are several methods on the basis of which frontal sinuses peculiar features can be matched between the antemortem and the postmortem records. The methods include superimposition, digital analysis and matching.<sup>16,17</sup>

A study was conducted on the frontal sinuses of the adults living in Karnataka, India. The research has concluded that there exists high level of asymmetry among the frontal sinuses anatomy of the research subjects.<sup>18</sup> The frontal sinus anatomy can be appreciated with ease and simplicity on the radiographs. The radiological procedure is

cost effective than the other available methods of identification.<sup>19,20</sup>

The forensic importance of the frontal sinuses unique features make them an ideal tool in identification. In Pakistan, both the natural calamities as well as the terrorist unrest are common over the period of years. According to report that was published by the Global Terrorism Data (GTD) and Pakistan Emergency Database (EM-DAT), the number of diasters are on the rise. In total, forty five natural diasters were reported and the numbers documented for the terrorist activities were 289 spanning from the period of 2003 to 2017.<sup>21</sup>

Over the world, literature search has documented the importance of the application of knowledge of frontal sinus anatomy in identification of the deceased with unknown identity. No research has been done so far in our country employing the use of frontal sinuses peculiar features as an identification tool. In our country, due to rise of suicide attacks as well as natural disasters, identification of the deceased remains a perplexed task for the forensic team experts and the anthropologists. Henceforth, this study was planned in order to document the morphology as well as variations among the adult male members living in Karachi belonging to different ethnic groups. The research could help the forensic experts in establishing identity in our region of the world.

## MATERIAL & METHODS

The present research was conducted at the Jinnah postgraduate Medical Centre - Radiology Department. Ethical approval letters were issued by the ERC, BUMDC and IRB, JPMC. The study design employed was descriptive - cross sectional study. The total calculated sample size was 108. It was calculated by the help of Open epi calculator. The individual study period was 50 minutes and the total study period was 6 months. The recruited participants were divided into four ethnic sub groups. The ethnic subgroups were Sindhi, Pathan, Punjabi and Urdu speaking. Each ethnic sub group had 27 members. Average age of the participants was 35.14 + 8.68 years. Adult

males between 20 to 50 years, free of paranasal sinus diseases were included in the research. Subjects who had previous paranasal sinus disease or surgery were excluded. Informed consent was taken from the participants prior to the start of the research. The participants were made part of the research once they voluntarily became involved. Occipitomenal (Water's view) was taken by the STEPHNEX machine. The radiology was done in room number 2 of the radiology department. The X-ray film was saved and then measurements were calculated by Radiant DICOM software. All the parameters were measured according to the criteria set by Ribeiro.<sup>17</sup>

Firstly, a baseline was drawn on the upper region of the two orbits. It was labelled as A. Then highest point of the right sinus was marked B. A line C, was drawn from B till the line A and it represented right frontal sinus height. Then highest point of the left sinus was marked D. A line E, was drawn from D till the line A and it represented left frontal sinus height. Line F was drawn at the most lateral extent of right frontal sinus. Line G (right width) was drawn from septum till the line F. Line H was drawn at the most lateral extent of left frontal sinus. Line I (left width) was drawn from septum till the line H. The area of the right frontal sinus was calculated as a product of right frontal sinus height and width. The area of the left frontal sinus was calculated as a product of left frontal sinus height and width.

The data analysis was done by the help of SPSS version 23.0. One Way ANOVA was used to compare the ethnic groups in terms of height, width and area for both the right and the left frontal air sinuses. The continuous data was represented as mean  $\pm$  SD. The results were considered to be significant when the p value was  $<0.05$  and highly significant when the p value was  $<0.001$ .

## RESULTS

When mean heights of frontal sinuses were compared among the male ethnic group members, highly significant variations were noted in the right frontal sinuses. (Table-I, Figure-1). Variations were also documented in the left frontal sinuses when

height, width and area were compared among the male ethnic group members. The lowest mean values were recorded for the Sindhis and the highest values were calculated for the Pathans. (Table-II, Figure-1).

Ethnicity	n	Right side Mean ± SD	P-Value
Sindhi	27	1.32 ± 0.16	0.000**
Pathan	27	2.87 ± 0.47	
Punjabi	27	2.59 ± 0.29	
Urdu speaking	27	2.40 ± 0.51	

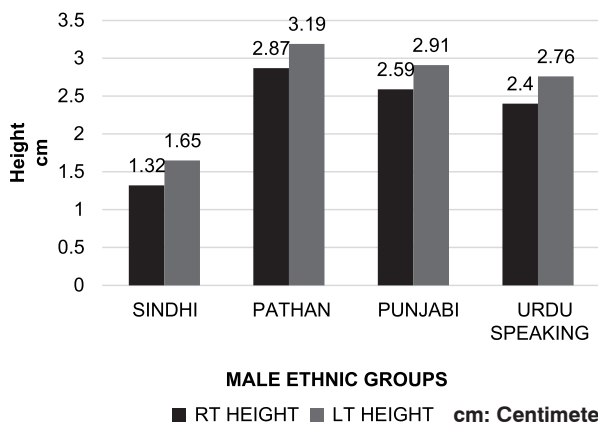
**Table-I. Comparison of mean heights of right frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA

Ethnicity	n	Left side Mean ± SD	P-Value
Sindhi	27	1.65 ± 0.20	0.000**
Pathan	27	3.19 ± 0.23	
Punjabi	27	2.91 ± 0.27	
Urdu speaking	27	2.76 ± 0.44	

**Table-II. Comparison of mean heights left frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA



**Figure-1. Comparison of mean heights of right and left frontal sinuses among the male ethnic groups**

When mean widths were compared among the male ethnic group members, highly significant variations were noted for both the right and left frontal air sinuses. The highest mean values

were recorded for the Pathans, followed by the Punjabis and the Urdu speaking. The lowest values were calculated for the Sindhis. (Tables-III and IV, Figure-2).

Ethnicity	n	Right side Mean ± SD	P-Value
Sindhi	27	1.71 ± 0.19	0.000**
Pathan	27	3.26 ± 0.32	
Punjabi	27	2.99 ± 0.24	
Urdu speaking	27	2.90 ± 0.29	

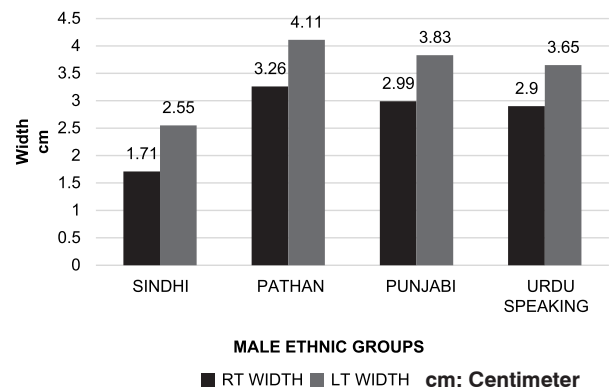
**Table-III. Comparison of mean widths of right frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA

Ethnicity	n	Left side Mean ± SD	P-Value
Sindhi	27	2.55 ± 0.22	0.000**
Pathan	27	4.11 ± 0.29	
Punjabi	27	3.83 ± 0.27	
Urdu speaking	27	3.65 ± 0.32	

**Table-IV. Comparison of mean widths of left frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA



**Figure-2. Comparison of mean widths of right and left frontal sinuses among the male ethnic groups**

When mean areas were compared among the male ethnic group members, highly significant variations were noted in the right frontal sinuses. (Table-V, Figure-3). Variability in anatomical details were also noted when the ethnic group members left sided dimensions were compared.

The lowest mean values were recorded for the Sindhis followed by the Urdu speaking and the Punjabis. The highest values were calculated for the Pathans. (Table-VI, Figure-3).

Ethnicity	n	Right side Mean $\pm$ SD	P-Value
Sindhi	27	2.28 $\pm$ 0.43	0.000**
Pathan	27	9.35 $\pm$ 1.63	
Punjabi	27	7.76 $\pm$ 1.12	
Urdu speaking	27	6.91 $\pm$ 1.26	

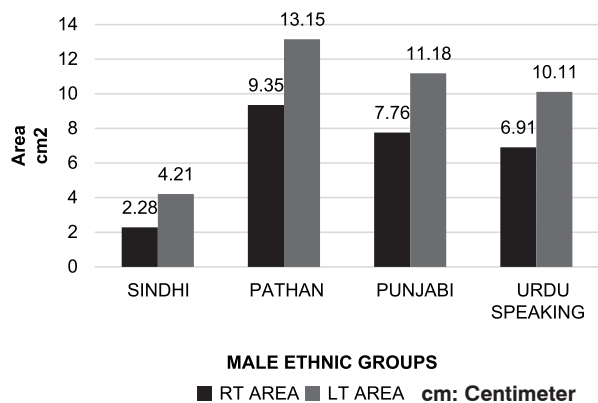
**Table-V. Comparison of mean areas of right frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA

Ethnicity	n	Left side Mean $\pm$ SD	P-Value
Sindhi	27	4.21 $\pm$ 0.57	0.000**
Pathan	27	13.15 $\pm$ 1.28	
Punjabi	27	11.18 $\pm$ 1.29	
Urdu speaking	27	10.11 $\pm$ 1.94	

**Table-VI. Comparison of mean areas of left frontal sinuses among the male ethnic groups n= 108**

P value significant < 0.05\*, highly significant: < 0.001\*\*  
Test applied: One-Way ANOVA



**Figure-3. Comparison of mean areas of right and left frontal sinuses among the male ethnic groups**

## DISCUSSION

The structural anatomy of the frontal sinuses differs in every person. The distinctive and unique appearance of the frontal sinus is due to its independent development. The resorption of the spongy bone that is present between the inner and outer layers of the compact bones

occurs at a variable pattern.<sup>22</sup> The current study has documented variations in the morphological pattern of the frontal sinus structural organization. Analogous findings documenting the variability pattern was documented in a research conducted on the adults of Nigeria.<sup>23</sup> Parallel findings were also noted in the studies conducted in Karnataka and Manipal regions of India.<sup>24,25</sup>

In the present study, the participants were selected who were in age range of twenty to fifty years. Pradhan selected participants in similar age range in a study conducted on the Indian population.<sup>25</sup> The frontal sinus development is completed by the age of fourteen years.<sup>26</sup> It has been documented that the growth of the frontal sinus is completed once the individual reaches the age of puberty.<sup>27</sup> The frontal sinus development is variable but as documented it is completed by the age of twenty years.<sup>22</sup>

The present study demonstrated variance in the dimensions of the frontal sinuses among the different ethnic groups living in Karachi. The mean value for the right frontal air sinus height showed variations in the different male ethnic groups. Dissimilarities were also observed when the left frontal air sinuses dimensions were compared among the four male ethnic groups. The height of the right and the left frontal air sinuses were lowest in the Sindhi males and highest in the Pathan males. The right and the left sided heights of the Punjabi males were higher than that of the Urdu speaking males. Similar variations have also been reported in the researches conducted on the Indian ethnic groups members.<sup>25,28</sup> The explanation for the variability in the heights both on the right and the left sides can be attributed to the developmental changes which occur before the frontal sinuses assume their final shape. When the diploe is absorbed in between the two parts of the frontal bone; the resorption of the spongy bone differs in every person.<sup>29</sup>

In the present study, the mean widths of right and the left frontal sinuses have shown significant variation among the participants of the male ethnic groups. The Pathan males have the highest measurements followed by the Punjabi, Urdu



speaking and the Sindhi males. Differences in the width of frontal air sinus have also been reported by researches conducted across different regions of India.<sup>30,31</sup>

This variation in the widths could be due to the inconsistent process of pneumatization. The two frontal air sinuses acquire pneumatization at a variable pattern and it is independent.<sup>32</sup>

In the current research, the mean value for the right frontal air sinus area in the different male ethnic groups showed significant variations. Dissimilarities were also observed when the left frontal air sinuses areas were compared among the four ethnic groups. When compared, the mean area of the right and the left frontal air sinuses were lowest in the Sindhi males and highest in the Pathan males among the four male ethnic groups. The right and the left sided area of the Punjabi males were higher than that of the Urdu speaking males. The alterations in the area occupied by the two frontal air sinuses can be explained on the basis of the metopic suture growth pattern variations. The size of the metopic suture in human populations differ and the difference leads to the individual change in size and growth pattern of the frontal air sinus.<sup>29</sup> The metopic sutures persistence is associated with the smaller sizes of the frontal air sinuses. Thus it is postulated that in those persons where metopic suture persists, the size of the frontal size becomes small and vice versa.<sup>33</sup> Another explanation put forward by a research article is the presence or absence of the inter frontal sinus suture. Inter frontal suture does not exist after the eight years of life but if it does it affects the size pattern of the frontal sinuses.<sup>34</sup>

### CONCLUSION

The height width and area show pattern of anatomical variability in the right and left frontal air sinuses among the ethnic groups of males living in Karachi.

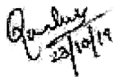
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**AUTHORSHIP AND CONTRIBUTION DECLARATION**

Sr. #	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Quratulain Javaid	Substantial contribution to conception and design or acquisition of data, or analysis and interpretation of data. Drafting the article or revising it critically for important intellectual content. Final approval of the version to be published.	
2	Ambreen Usmani	Agreement to be accountable for all aspects of work in ensuring that questions related to accuracy or integrity of any part of the work are appropriately investigated and resolved.	