PAKISTAN JOURNAL OF HEALTH SCIENCES
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 8 (August 2024)

Original Article

OPEN ACCESS

Sex-Based Differences in Frontal Sinus Anatomy: A Cross-Sectional Study

Humaira Imtiaz[1], Munila Shabnum Khattak[2*], Nida Qasim Hayat[3], Omair Jadoon[4], Atif Hussain[5] and Sadaf Shaheen[5]

[1]Department of Anatomy, Ayub Medical College, Abbottabad, Pakistan
[2]Department of Anatomy, Khyber Medical College, Peshawar, Pakistan
[3]Department of Anatomy, Women Dental College, Abbottabad, Pakistan
[4]Department of Forensic Medicine and Toxicology, Ayub Medical College, Abbottabad, Pakistan
[5]Department of Anatomy, Women Medical College, Abbottabad, Pakistan

ARTICLE INFO

Keywords:
Frontal Sinus, Cells, Sinus and Height

How to Cite:
Imtiaz, H., Khattak, M. S., Hayat, N. Q., Jadoon, O., Hussain, A., & Shaheen, S. (2024). Sex-Based Differences in Frontal Sinus Anatomy: A Cross-Sectional Study: Sex-Based Differences in Frontal Sinus Anatomy. Pakistan Journal of Health Sciences, 5(08). https://doi.org/10.54393/pjhs.v5i08.1846

***Corresponding Author:**
Munila Shabnum Khattak
Department of Anatomy, Khyber Medical College, Peshawar, Pakistan
m.khattak585@gmail.com

Received Date: 4th June, 2024
Acceptance Date: 26th August, 2024
Published Date: 31st August, 2024

ABSTRACT

Within the frontal bone of the skull, directly above the eyebrows and behind the forehead, lies an air-filled chamber known as the frontal sinus. **Objective:** To investigate sex-based differences in frontal sinus anatomy, including measurements such as height, width, and area. **Methods:** This cross-sectional study was conducted at the Department of Anatomy, Women Medical and Dental College, Abbottabad from January 2023 to December 2023. A total of 300 participants were (N = 300). The participants were divided into two groups: 160 men and 140 women. The participants were physically examined using a radiological process. **Results:** The female and male mean age of 35.2 ± 18.5 years. The right and left side areas of the frontal sinus were significantly higher in males 77.7% and 82.8%, respectively; p = 0.0001) than in females. Males had a significantly greater height (73.3%) and 75.9 % (p = 0.0001) than females on both sides. It was shown that the right and left side widths in males 79.6% and 74.4% significantly higher, p = 0.0001 as compared to females. Males had more supra agger frontal cells and supraorbital ethmoid cells (78.1% and 81.2%, respectively; p < 0.0001). **Conclusions:** It was concluded that males have larger frontal sinuses in terms of height, width, area, and ethmoid air cell count than females. These results indicate that males have larger and more developed frontal sinuses than females.

INTRODUCTION

The frontal sinuses are air-filled chambers located within the frontal bone of the skull, positioned just above the eye sockets and behind the forehead. These paired sinuses are a part of the paranasal sinus system, which is a network of hollow spaces in the facial bones that connect with the nasal cavity. During childhood, the frontal sinuses grow and reach full maturity by early adulthood [1]. The frontal sinus is a sex discrimination indication; nonetheless, the frontal sinus sex discrimination rate was lower than that of the classic morphological approaches. We devised a novel approach that measures the frontal sinus area and index from lateral cephalogram radiographs to increase the sex discrimination percentage [2]. This narrow opening is called an ostiumthus permits mucus (liquid) to come out from its residence and go down toward the nose where It can be breathed out with following air. Some anterior ethmoid cavities vented into the medial turbinal, though others neared the nostril's perimeter. Healthy individuals may glimpse all-natural openings. The lamina completely plates the medial orbital wall, necessitating an incision through the anterior ethmoid bone to view. Fixed specimens expose the hard palate posterior to the nasal cavity. Ciliated cells in nasal and paranasal mucosa, including ethmoids and maxillae, coordinate mucus and debris propulsion toward Ostia draining into passages. Scattered ciliated cells line these cavities. For example, the frontal sinus secretes mucus via goblet rather than ciliated cells, keeping its region moistened and hospitable. While most sinus cavities exhibit concerted cilia, variances like frontal mucous membranes diversify constitution along

DOI: https://doi.org/10.54393/pjhs.v5i08.1846

the complex networked airways [3]. The sinus cavity is lined by a mucous membrane on the interior part of the sinuses. The hollow cavities filled with air lie in the skull region and generate mucus continuously. The mucus helps to keep the nasal passages inside moist and keeps the lining of the sinuses dampened. Meanwhile, it provides a physical barrier that is vitally necessary to ensure that any foreign object, bacteria or virus which might enter one's lungs thus making way for infection is blocked by mucus. The frontal sinus drains into the ethmoid cell group adjacent to it, or ethmoid cells but other parts of this area have pseudo-stratified ciliated cells. Cilia, hairlike structures finer than 10 microns, can act as brooms that pinch off and remove mucus or small solid objects from the sinuses. One of the leading candidates of how content within the sino-nasal cavity drains outward now is that ciliated cells with hair-like structures thinner than 10 microns sweep out mucus and dirt This is in contrast to the way Cilia overlap and collectively move: in the coordinated flows that lead to the motion of large biofilm aggregates across ostia toward natural or iatrogenic openings [4]. This is an example of normal anatomical drainage by an emissary conduit through which mucus comes and goes to the nasal cavity. In humans, the paranasal sinuses are connected by their ostia-the opening of one sinus into another. This enables mucus and air exchange between individual sinuses as well as with those of the nasal cavity itself [5]. In the head and neck region, one of the most challenging anatomical formations is the drainage system of our frontal sinuses. For many people, this opening is wider than the one that connects the frontal sinus to the surrounding structures, be it teeth or nostrils. Some individuals have them in between their navel and nasal cavity, among other anatomical stoppages, for instance. Any disturbance by inflammation causes any of the extra holes to assume a different position internally, thereby affecting the drainage sinuses' curves [6]. As a result, the sinuses will deviate from the expected functioning way causing functional chaos. The size of the nasofrontal duct in the frontal sinus can affect the path of drainage. It is a small channel that flows through the frontal recess and into the nasal cavity [7]. On one hand, when the nasofrontal duct is very large and wide open, this affects the path of drainage of the frontal sinus. The position of the nasofrontal duct at a far distance from the nasal floor because of the minimal attachment of the floor affects the amount and path of drainage. On the other hand, frontonasal duct patency is also influenced by the frontal sinus, which contributes to 34% of changes in front frequency. The frontal sinus may account for 37.5% of changes in duct patency, as draining occurs in the ethmoid infundibulum in approximately 81.8% of cases. On the drainage passage, Braun states that it has been noticed that the sinus opens in the middle nasal meatus [8]. The quality of functional results and understanding of the structure of this labyrinth improve with continuous research, but it is also one reason that success rates are much higher at present than in its initial report. The increased use though has significantly changed our perception of forehead sinus shape and adjacent sinus structures as seen on these high-resolution scans. The Fourier transform of three-plane images rendered by CT clearly shows important anatomic relationships. If the surgeon has an unusual level of expertise, may profit from utilizing that feature with optimum benefits to patients. Depending on how one interprets such data and what experience in this kind of operation has previously, combining these factors into some degree of predictability-procedure manipulation becomes more challenging than simply performing procedures later in an operating room environment. A surgeon can find the important structures of the frontal sinus and prepare a surgical approach that is structured according to the structure of complexity which it holds. Its specific anatological variations however have to be managed before performing the surgery [9, 10]. This study aimed to examine gender-based differences in frontal sinus anatomy, including measurements such as height, width, and area, as well as the presence of ethmoid air cells like the supra agger frontal cell and the supraorbital ethmoid cell.

METHODS

This cross-sectional study was conducted at the Department of Anatomy, Women Medical and Dental College, Abbottabad, from January 2023 to December 2023. The total number of participants in this study was (N=300). The participants were divided into two groups: male and female. The inclusion criteria included general population, both male and female sex and an age range of 18-52 years. No history of sinus disease, trauma, or surgeries affecting. Exclusion criteria were pregnancy, sinus surgery, and facial anomalies. The formula for calculating sample size often involves these factors. For a cross-sectional study comparing two independent groups (males vs. females), the sample size formula can be: n= 2. (z α/2+Zβ)2 σ2 / d2. Zα/2 is the critical value for the desired significance level (1.96 for α=0.05\alpha = 0.05α=0.05). Zβ is the critical value for the desired power (0.84 for 80% power). σ is the estimated standard deviation of frontal sinus measurements. d=0.05 is moderate effect size. Frontal sinus dimensions for both right and left sinuses (width, height & anteroposterior lengths) were measured from axial and coronal sections (4-mm slice thickness) using multi-detector computed tomography (MDCT) scanner. This study was approved by the Institutional Review Board (IRB) reference number (WMC /Estb/20042), Women Medical and Dental College, Abbottabad. Data were statistically analyzed using SPSS software 26.0. Independent T-test, when comparing the means of

DOI: https://doi.org/10.54393/pjhs.v5i08.1846

continuous variables Height, Width, and Depth between two separate groups, such as males and females, the independent t-test is utilized. Categorical Variables (Presence of Septa, Symmetry) were presented as frequencies and percentages. Odds ratios (OR) and confidence intervals (CI) are reported to describe the likelihood of these variations occurring in males versus females. The variables were considered to be significant, as indicated by a p-value of <0.05.

RESULTS

A total of 300 participants were included in the study, consisting of both males and females. Of these, 140 (46.6%) were female and 160 (53.3%) were male. The age range of the participants was between 18 and 52 years, with a mean age of 35.2 ± 18.5 years. Out of the 300 participants who underwent frontal sinus assessment (100%), this reduction in sample size was accounted for in table 1.

Table 1: Demographic Variables

Variables	Total Number of Participants = 300 Mean ± SD Or % Age
Age	
Mean ± SD	35.2 ± 18.5 years
Gender	
Female	(140) 46.6%
Male	(160) 53.3%
Frontal Sinus	
Present	300 (100%)

When analyzing the dimensions of the right and left frontal sinuses, there were generally notable dissimilarities between male and female participants. The measurements revealed a statistically significant difference in the area of the frontal sinuses between male and female participants. Specifically, the right and left side areas of the frontal sinus in male participants were found to be significantly higher 350 ± 49.5 and 352 ± 51.2 mm^2 respectively, compared to females, with a p-value of 0.0001. These findings imply a potential gender-based distinction in the development of sinuses, as shown in table 2.

Table 2: Evaluate The Area Variation in Frontal Sinus Anatomy in Both Gender

Area (mm^2)	Male	Female	p-value
Right Area	350 ± 49.5	310 ± 43.3	<0.0001
Left Area	35 2 ± 51.2	315 ± 42.5	<0.0001

Our findings show that there were often substantial disparities in the height of the right and left frontal sinuses between male and female gender groups. Specifically, the height on the right side was significantly reduced in female participants by 30.7 ± 4.2 mm, p = 0.0001 compared to males 35.5 ± .1 mm, while the height on the left side was also significantly reduced by 32.5 ± 2.5 mm, p = 0.0001 in females relative to males 37.6 ± 3.2 mm. On the other hand, males had significantly greater heights in both the left and right frontal sinuses, p = 0.0001 respectively, as compared to females in table 3.

Table 3: Evaluate The Height Variation in Frontal Sinus Anatomy in Both Gender

Height (mm)	Male (160)	Female (140)	p-value
Right Height	35.5 ± 5.1	30.7 ± 4.2	<0.0001
Left Height	37.6 ± 3.2	32.5 ± 2.5	<0.0001

In fact, in 40.3 ± 2.5 mm of male participants, the right side width was significantly higher than in female 36.5 ± 4.5 mm participants, with a p-value of 0.0001. Additionally, in 41.1 ± 3.5 mm of male participants, the left side width was also significantly greater than in female participants 32.3 ± 5.1 mm, with a p-value of 0.0001. Overall, our results indicate that males have a significantly greater width than females in both the right and left frontal sinuses, as shown in table 4.

Table 4: Evaluate The Width Variation in Frontal Sinus Anatomy in Both Gender

Width (mm)	Male	Female	p-value
Right Width	40.3 ± 2.5	36.5 ± 4.5	<0.0001
Left Width	41.1 ± 3.5	32.3 ± 5.1	<0.0001

Supra-Ager Frontal Cell prevalence is considerably higher in men (78.1%) than in women (64.2%). When a difference is statistically significant, the p-value is less than 0.0001. The prevalence of Supra Orbital Ethmoid Cells is significantly higher in males (81.2%) than in females (77.1%). A statistically significant difference is indicated by the p-value of less than 0.0001, and the odds ratio supports the significance of the difference by suggesting that males are more likely to have these cells. There were no statistically significant differences between the sexes in Agger Nasi Cells, Supra Ager Cells, Supra Bulla Cells, Supra Bulla Frontal Cells, or Frontal Septal Cells. Supra Agger Frontal Cell and Supra Orbital Ethmoid Cell show significant differences between genders, with males being more likely to have these cells. Significantly more common in males than in females, with a p-value <0.0001 and OR (0.31 (1.21-4.57) and (0.22 (1.10- 3.54) suggesting a notable difference. Data by sex were presented in table 5.

Table 5: Evaluate The Sex Variation in Frontal Sinus Anatomy in Both Gender

Anterior Cells	Male	p-value	Female = 140	p-value	Odd Ratio or 95% CI
Agger Nasi Cells	16 (10%)	1.5439	25 (17.8%)	1.6777	1.21 (0.32, 3.61)
Supra Ager Cell	19 (11.8%)	0.6590	30 (21.4%)	0.5232	2.11 (0.15, 3.41)
Supra Ager Frontal Cell	125 (78.1%)	<0.0001	90 (64.2%)	<0.0001	0.31 (1.21-4.57)
Posterior Cells					
Supra Bulla Cell	16 (10%)	3.7650	18 (12.8%)	1.8780	2.43 (0.13, 0.47)
Supra Bulla Frontal Cell	15 (9.3%)	0.5421	14 (10%)	1.9899	1.21 (2.2, 4.1)
Supra Orbital Ethmoid Cell	130 (81.2%)	<0.0001	108 (77.1%)	<0.0001	0.22 (1.10-3.54)
Middle Cell					
Frontal Septal Cells	40 (25%)	0.9879	20 (14.2%)	0.0098	3.81 (1.30-4.66)

DOI: https://doi.org/10.54393/pjhs.v5i08.1846

DISCUSSION

Frontal sinuses are unique to each individual. These sinuses vary significantly in size, shape, pneumatization, septation and position. This variation is influenced by genetics, age, and anatomy. Individual sinuses may grow and pneumatize differently owing to genetic variation [11]. Variations in the structure of the frontal bone and surrounding structures can have an impact on the sinus arrangement. The development of frontal sinuses takes time, and the level of pneumatization varies with age. Sinus volume and pneumatization levels can fluctuate throughout a person's life [12]. In the current study, we found that frontal sinus development and growth were linked to particular age-related stages of skull growth. The frontal sinuses often alter significantly during childhood, adolescence, and early adulthood, as part of the overall craniofacial development process. These modifications can be divided into many major stages: Frontal sinuses are typically missing or poorly formed at birth 18 years. As the skull grows and matures, the frontal sinuses expand and become more pneumatized. Growth is influenced by both puberty-related hormone changes and hereditary factors [13]. The timing and breadth of frontal sinus development vary between individuals and are affected by genetic, environmental, and craniofacial growth trends. Understanding age-related variations in frontal sinus development is critical for the accurate interpretation of imaging investigations and clinical assessments, especially in pediatric and adolescent populations. A maximum age restriction of 52 years ensured a proper anatomical morphology. The previous study was shown that age significantly involve in the frontal sinus development of male gender then female [14, 15]. For certain, sexual variances in grown persons' frontal sinus elevations would derive from an assortment of considerations. While it troubles all patients alike, idiosyncrasies in form or measurement may distinguish him or her. Ordinarily, males' craniums expand farther and traits more boldly, perhaps adding to more expansive frontal sinuses [16]. Hormonal fluctuations, especially throughout pubescence, can sculpt osseous maturation and face articulation. Testosterone in higher amounts among males than females could impact frontal sinus inflation and development. Too, innate tendencies may rework the elevation or profile of the frontal sinuses. Dissimilarities in the genetic codes governing craniofacial advancement might underlie the gender contrasts in frontal sinus height seen. Nonetheless, these results must be set in the context of this evaluation's demographic particulars along with any confounding elements that could sway frontal sinus shape. We agreed with the previous study [17]. The measurement for the width of both right and left side frontal sinuses were significantly greater in males than females, indicating a sex-based difference observed among genders regarding dimension [18]. The data indicate that the overall frontal sinuses are wider for males compared to females in this sample population. General morphological differences of males with broader faces and generally larger cranial dimensions compared to females account for wider frontal sinuses. Androgens, particularly testosterone which is more abundant in men than women may contribute to bone formation and remodeling leading to the increased size of frontal sinus cavities. The previous literature showed that the left and right width changes significantly in the male gender and the female [19, 20]. Males have significantly larger left and right frontal sinuses than females, and the size of the frontal sinuses is related to gender. For most of the time, males had a larger surface area of the left frontal sinus than females, on average. Males in general display larger cranial dimensions and more prominent facial characteristics than their female peers, which might be the basis of a larger area in the frontal sinus. Hormonal parameters such as testosterone affect bone growth and development. The proliferation and pneumatization of frontal sinuses might be influenced by androgens, which are more abundant in males—this would lead to a larger surface area. Locus-specific genetic variables related to gender differences could account for variation in the frontal sinus area between males and females. Gastronomic behaviour, level of physical activity, and exposure to environmental threats could all be influential factors in determining the focal between sexes of craniofacial. The previous study showed frontal sinus changes significantly in male gender than female [21, 22]. Our study proved that in colour, taste and properties of the supra agger frontal cell and supraorbital ethmoid cell of the frontal sinuses varied greatly in men from those found in their female counterparts. Bigger in males than females were those supraorbital ethmoid and supraagger frontal cells, respectively. The supra agger frontal cell and supraorbital ethmoid cell lie just adjacent to the frontal sinuses and one form of these are ethmoid air cells. Different shapes and sizes of frontal cells with variable degrees of pneumatization directly influence the morphology of neighboring sinuses The supra agger frontal cell and the infraorbital ethmoidal cells usually originated from both anterior air space in the region of frontonasales; the other two predisposing sites occupied by such kind of pattern, whereas all occur mainly at one side. This disrupts the passage of air and moisturize formed in social autism. The effect is dysfunction and free flow of fluids from frontal sinuses, which may adversely affect the sinus health state. We agreed with the previous study [23].

CONCLUSIONS

It was concluded that males have larger and more developed frontal sinuses than females, with males having larger frontal sinuses in terms of height, width, and area. As a cross-sectional study, it can only establish associations

DOI: https://doi.org/10.54393/pjhs.v5i08.1846

rather than causal relationships. Longitudinal studies would be needed to explore how anatomical differences might influence sinus health and disease progression over time.

Authors Contribution

Conceptualization: HI, MSK, NQH, OJ, AH, SS
Methodology: MSK
Formal analysis: CR, DC
Writing-review and editing: ME

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Mohamed SA. Human Sex Identification from Frontal and Maxillary Air Sinuses Using Ct Scan. The Egyptian Journal of Forensic Sciences and Applied Toxicology. 2020 Jun; 20(2): 31-43. doi: 10.21608/ejfsat.2019.16220.1091.

[2] Luo H, Wang J, Zhang S, Mi C. The application of frontal sinus index and frontal sinus area in sex estimation based on lateral cephalograms among Han nationality adults in Xinjiang. Journal of Forensic and Legal Medicine. 2018 May; 56: 1-4. doi: 10.1016/j.jflm.2017.12.014.

[3] Davraj K, Yadav M, Chappity P, Sharma P, Grover M, Sharma S *et al*. Nasal physiology and sinusitis. Essentials of Rhinology. 2021 Apr: 49-101. doi: 10.1007/978-981-33-6284-0_3.

[4] Toth F and Schumacher J. Paranasal sinus cyst. Academic Press: In Comparative Veterinary Anatomy. 2022 Jan; 586-598. doi: 10.1016/B978-0-323-91015-6.00139-4.

[5] Yücel L, Azizi F, Meral SC, Sözer ÇS, Erol AS, Çoşkun ZÜ *et al*. Changes in paranasal sinus volumes, temporal bone pneumatization, internal acoustic canal and olfactory cleft dimensions over the centuries: a comparison of skulls from different epochs in Anatolia. European Archives of Oto-Rhino-Laryngology. 2024 Jul; 1-8. doi: 10.1007/s00405-024-08804-9.

[6] Chatra L, Fasla EK, Shenoy P, Veena KM, Prabhu R. Sexual dimorphism in frontal sinus volume: A CBCT comparative study. Journal of Indian Academy of Forensic Medicine. 2020 May; 42(3): 172-6. doi: 10.5958/0974-0848.2020.00047.0.

[7] Iturralde-Garrote A, Sanz JL, Forner L, Melo M, Puig-Herreros C. Volumetric Changes of the Paranasal Sinuses with Age: A Systematic Review. Journal of Clinical Medicine. 2023 May; 12(10): 3355. doi: 10.3390/jcm12103355.

[8] Bhalla RK. Applied Anatomy of the Nose and Sinuses. In Contemporary Rhinology: Science and Practice. Cham: Springer International Publishing. 2023 Nov; 13-32. doi: 10.1007/978-3-031-28690-2_2.

[9] Waluyo RF, Priaminiarti M, Yuniastuti M, Soedarsono N, Susilo BT. Measurements of sex-related differences in maxillary sinus and mandibular canal characteristic using cone beam computed tomography. Forensic Imaging. 2020 Jun; 21: 200371. doi: 10.1016/j.fri.2020.200371.

[10] Butaric LN, Jones GC, Garvin HM. Revisiting global patterns of frontal sinus aplasia utilizing computed tomography. Forensic Science International. 2020 Oct; 315: 110458. doi: 10.1016/j.forsciint.2020.110458.

[11] ElBeshlawy DM and Helaly YR. Frontal sinus index for sex estimation: Is it possible?. Forensic Imaging. 2020 Dec; 23: 200407. doi: 10.1016/j.fri.2020.200407.

[12] Lee JH and Park JT. Three-Dimensional Evaluation of the Frontal Sinus in Koreans. International Journal of Environmental Research and Public Health. 2022 Aug; 19(15): 9605. doi: 10.3390/ijerph19159605

[13] Ramkumar SP, Brar T, Marks L, Marino MJ, Lal D. Biological sex as a modulator in rhinologic anatomy, physiology, and pathology: a scoping review. In International Forum of Allergy & Rhinology. 2023 Sep; 13(9): 1783-1800. doi: 10.1002/alr.23135.

[14] Abdalla MA. Human maxillary sinus development, pneumatization, anatomy, blood supply, innervation and functional theories: An update review. Siriraj Medical Journal. 2022 Jul; 74(7): 472-9. doi: 10.33192/Smj.2022.56.

[15] Aslıer NY, Zeybek G, Karabay N, Keskinoğlu P, Kiray AM, Sütay S *et al*. The relationships between craniofacial structure and frontal sinus morphology: evaluation with conventional anthropometry and CT-based volumetry. Ear, Nose and Throat Journal. 2020 Dec; 99(10): 637-47. doi: 10.1177/0145561319876927.

[16] Abdalla MA. Pneumatization patterns of human sphenoid sinus associated with the internal carotid artery and optic nerve by CT scan. Romanian Journal of Neurology. 2020 Oct; 19(4): 244-51. doi: 10.37897/RJN.2020.4.5.

[17] Espersen J, Weber U, Römer-Franz A, Lenarz T, Stolle SR, Warnecke A. Level of sex hormones and their association with acetylsalicylic acid intolerance and nasal polyposis. PLoS One. 2020 Dec; 15(12): e0243732. doi: 10.1371/journal.pone.0243732.

DOI: https://doi.org/10.54393/pjhs.v5i08.1846

[18] Ekpruke CD and Silveyra P. Sex differences in airway remodelling and inflammation: clinical and biological factors. Frontiers in Allergy. 2022 Apr; 3: 875295. doi: 10.3389/falgy.2022.875295.
[19] Tornese G, Pellegrin MC, Barbi E, Ventura A. Pediatric endocrinology through syndromes. European Journal of Medical Genetics. 2020 Jan 1;63(1):103614. doi: 10.1016/j.ejmg.2019.01.004.
[20] Kyritsi EM and Kanaka-Gantenbein C. Autoimmune thyroid disease in specific genetic syndromes in childhood and adolescence. Frontiers in Endocrinology. 2020 Aug; 11: 543. doi: 10.3389/fendo.2020.00543.
[21] Schmidt M, Slavicek G, Slavicek F, Schulz MC, Aretxabaleta M, Effert J *et al*. Masticatory efficiency in orthodontic patients with craniofacial disorder. International Journal of Environmental Research and Public Health. 2023 Feb; 20(5): 4324. doi: 10.3390/ijerph20054324.
[22] Peris-Ramos HC, Míguez MC, Rodriguez-Besteiro S, David-Fernandez S, Clemente-Suárez VJ. Gender-Based Differences in Psychological, Nutritional, Physical Activity, and Oral Health Factors Associated with Stress in Teachers. International Journal of Environmental Research and Public Health. 2024 Mar; 21(4):385. doi: 10.3390/ijerph21040385.
[23] Gerald T and Raj G. Testosterone and the androgen receptor. Urologic Clinics. 2022 Nov; 49(4): 603-14. doi: 10.1016/j.ucl.2022.07.004.