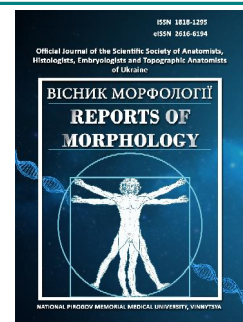




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# Peculiarities of correlations of upper respiratory tract cephalometric parameters in Ukrainian young men and young women regardless of face type

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### CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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The study of the parameters of the upper respiratory tract has become one of the leading directions of medical research, due to the connection of this structure with the occurrence and course of many diseases of both childhood and adulthood. The study of normative indicators of this structure and its relationship with craniometric indicators should be the first step before further research of samples with pathologies. The purpose of the study is to establish correlations of cephalometric parameters of the upper respiratory tract in Ukrainian young men and young women with an orthognathic bite, regardless of the type of face. Primary lateral radiographs of 49 Ukrainian young men (aged 17 to 21 years) and 76 Ukrainian young women (aged 16 to 20 years) with an orthognathic bite and the absence of upper respiratory tract pathology taken from the database of the research center and the Department of Pediatric Dentistry age of National Pirogov Memorial Medical University, Vinnytsia, with the help of the licensed medical software OnyxCeph<sup>3™</sup>, version 3DPro (Image Instruments GmbH, Germany) and the diagnostic program "UniqCeph", a cephalometric analysis of the upper respiratory tract was performed. In the "Statistica 6.0" license package, correlations between cephalometric indicators of the upper respiratory tract were assessed using non-parametric Spearman statistics. In Ukrainian young men, multiple, mostly direct, medium-strength ( $r$ = from 0.32 to 0.48) and strong ( $r$ = from 0.65 to 0.83) correlations were established between most of the characteristics of the upper respiratory tract or tongue; in young women, there are also predominantly direct, medium-strength ( $r$ = from 0.33 to 0.57) and strong ( $r$ = from 0.62 to 0.85) correlations between most of the characteristics of the upper respiratory tract or tongue, as well as medium-strength inverse ( $r$ = -0.30 and -0.40) and direct ( $r$ = 0.45 and 0.85) correlations between most characteristics of the soft palate. In addition, in Ukrainian young men, multiple inverse correlations of mainly medium strength ( $r$ = from -0.33 to -0.49) were established between the value of the PASmin distance and the UAA section with the value of the SPT distance and the SPA section, and between the value of the NL/PM-U angle and most of the characteristics of the tongue, as well as multiple direct, mostly medium strength ( $r$ = from 0.30 to 0.55), connections between the characteristics of the upper respiratory tract itself and the hyoid bone or tongue and between the characteristics of the hyoid bone and the tongue; in young women, there are mainly straight lines of medium strength ( $r$ = from 0.33 to 0.55) between the value of the AH-CV distance and most of the characteristics of the upper respiratory tract itself, between the value of the AH-FH distance and all characteristics of the tongue, and between the value of the PM-U distance and by the distance VT and the section TA. Thus, the most pronounced manifestations of sexual dimorphism of connections are established between the characteristics of the soft palate, between the characteristics of the upper respiratory tract itself and the soft palate or tongue, as well as between the characteristics of the soft palate and the hyoid bone.

**Keywords:** cephalometry, correlations, upper respiratory tract, soft palate, hyoid bone, tongue, Ukrainian young men and women, orthognathic bite, sexual dimorphism.

### Introduction

The study of both external and internal craniofacial (in particular, respiratory tract) structures is one of the debatable

issues of clinical medicine. However, as for most clinical sciences, biomedical anthropology is the primary and

fundamental beginning that will allow us to understand the interrelationship of various structures of the human body.

The human face and, in particular, the central craniofacial structures that form it are the result of many years of evolutionary processes. At the same time, the influence of external faciocranial structures on internal ones (and vice versa) is still a subject of scientific debate. The latest data indicate that the dimensional indicators of the respiratory tract are related to the peculiarities of the development of craniofacial indicators, while the peculiarities of the shape of the respiratory tract are formed to a greater extent depending on climatic changes [3]. Indeed, modern genetic studies show that some features of the morphology of the central part of the face (nasal, zygomatic parts) are formed under the influence of environmental temperature, intensity of solar radiation and atmospheric pressure, which is a vivid manifestation of compensatory and adaptive mechanisms in response to certain environmental parameters [7].

At the same time, the internal respiratory tract is a structure that is "more hidden" from external factors, which significantly interacts with its surrounding structures, such as the tongue, hyoid bone, etc. At the same time, such indicators as the size of the tongue, the length of the pharynx and the length of the mandibular plane to the hyoid bone are related to the weight of the human body, and as an example, in the case of obesity, an increase in their parameters causes an increase in the critical pressure on the closure of the pharynx, which is the driver of collapse in case of obstructive sleep apnea [12, 25].

In general, the study of the parameters of the respiratory tract has become the key to understanding the causes of the occurrence, course, and ways of treating various pathologies [20, 22]. This causes intensification of researchers' efforts with the aim of in-depth study of the parameters of these structures and their interaction with other structures.

No less important for understanding the picture as a whole is the analysis of the impact of orthognathic surgical intervention on subsequent changes in airway parameters. The meta-analysis data of 21 publications prove that, regardless of facial features or other patient data, respiratory parameters undergo various changes in their parameters, which do not return to their original values even 6 years after the intervention [8].

Thus, an intervention aimed at rapid expansion of the upper jaw causes an increase in the volume of the nasal cavity and nasopharynx already by 3 months [19]. At the same time, no significant differences were found in the change in the size of the oropharynx when using orthodontic treatment in adults [21].

However, the interpretation of certain results requires a correct understanding of the received radiological data, which requires the use of the correct positioning of the patient, otherwise it causes a distortion of the obtained indicators [15]. In addition, there is a need to obtain normative indicators of cranial indicators and indicators of the respiratory tract,

which would take into account the sex, age and ethnicity of the person. Such work is already being carried out [14], but it is also important to conduct research that would also study the relationships of these elements. The results of such studies on a healthy population of individuals would allow deepening the understanding of the interaction of these structures and thus help medical professionals involved in their treatment.

*The purpose of our study* is to establish correlations of cephalometric parameters of the upper respiratory tract in Ukrainian young men and young women with an orthognathic bite, regardless of facial type.

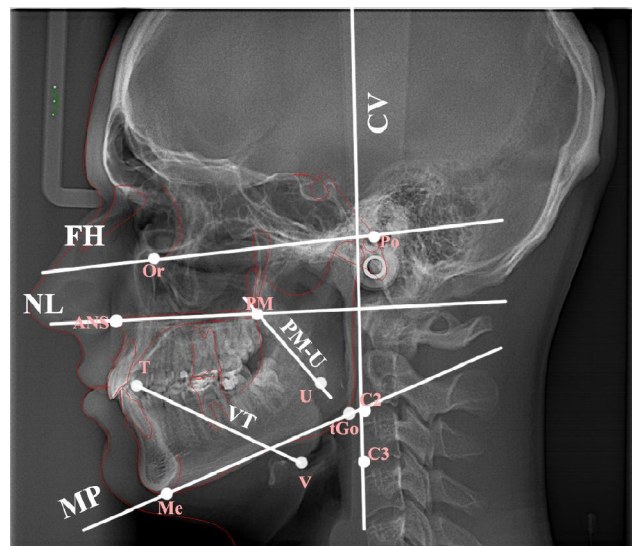
## Materials and methods

Primary lateral radiographs of 49 Ukrainian young men (YM) (aged 17 to 21 years) and 76 Ukrainian young women (YW) (aged 16 to 20 years) with orthognathic bite and absence of pathology of the upper respiratory tract. All of them underwent a teleröntgenographic (effective radiation dose up to 0.001 mSv) examination using a Veraviewepocs 3D Morita (Japan) dental cone-beam tomograph at the "Vinintermed" private dental clinic.

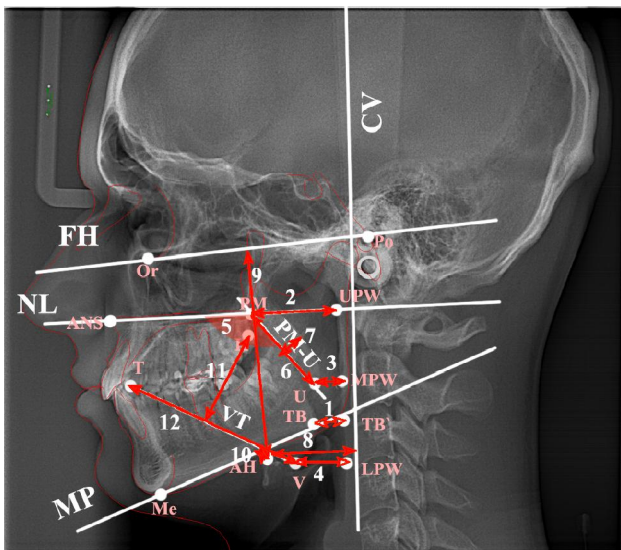
Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya (protocol № 8 From 30.09.2021) found that the studies do not contradict the basic bioethical standards of the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine (1977), the relevant WHO regulations and laws of Ukraine.

Cephalometric analysis of the upper respiratory tract was performed using licensed medical software OnyxCeph<sup>3™</sup>, version 3DPro (company Image Instruments GmbH, Germany) and diagnostic program "UniqCeph" (created in National Pirogov Memorial Medical University, Vinnytsya).

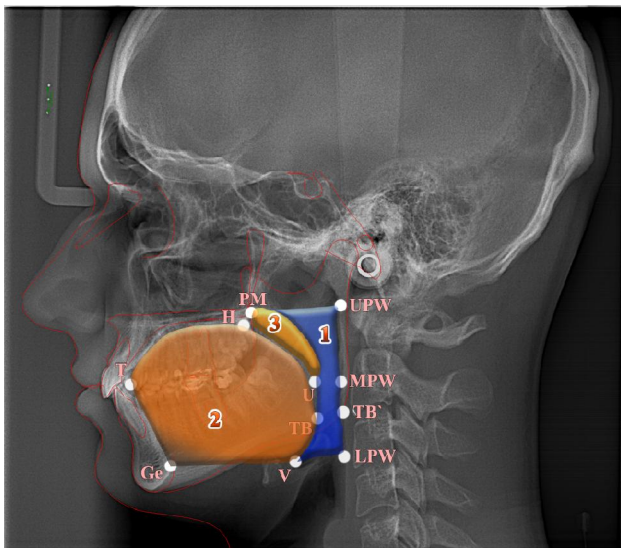
Figure 1 shows *lines used in cephalometric examination*



**Fig. 1.** Cephalometric lines used in cephalometric examination of the upper respiratory tract. CV - cervical plane; FH - Frankfurt plane; MP - mandibular plane; NL - nasal plane; PM-U - longitudinal axis of the soft palate; VT - longitudinal axis of the tongue.



**Fig. 2.** Cephalometric linear and angular characteristics used in cephalometric examination of the upper respiratory tract. 1 - distance PASmin, 2 - distance PM-UPW, 3 - distance U-MPW, 4 - distance V-LPW, 5 - angle NL/PM-U, 6 - distance PM-U, 7 - distance SPT, 8 - distance AH-CV, 9 - distance AH-FH, 10 - distance AH-MP, 11 - distance H-VT, 12 - distance VT.



**Fig. 3.** Cephalometric characteristics of the area used in the cephalometric study of the upper respiratory tract. 1 - area UAA (area of the upper respiratory tract), 2 - area TA (tongue area), 3 - area SPA (soft palate area).

of the upper respiratory tract [23]: plane CV - Cervical plane - passes through points C2 and C3; plane FH - Frankfort plane - passes through points Or and Po; plane MP - Mandibular plane - passes through points Me and tGo; plane NL - Nasal plane - passes through the ANS and PNS points; line PM-U - longitudinal axis of the soft palate - passes through points PM and U; line VT - longitudinal axis of the tongue - passes through points V and T.

Cephalometric indicators used in the cephalometric study of the upper respiratory tract are shown in Figures 2

and 3.

*Characteristics of the upper respiratory tract itself:*

- distance **PASmin** (also known as Retroglossal oropharyngeal airway space) - distance between points TB and TB` (mm);
- distance **PM-UPW** (also known as Nasopharyngeal airway space) - distance between points PM and UPW (mm);
- distance **U-MPW** (also known as Retropalatal oropharyngeal airway space) - distance between points U and MPW (mm);
- distance **V-LPW** (also known as Hypopharyngeal airway space) - distance between points V and LPW (mm);
- area **UAA** (also known as Upper airway area) - outlined by a contour through the points: PM - UPW - MPW - TB` - LPW - V - PM (mm<sup>2</sup>).

*Characteristics of the soft palate:*

- angle **NL/PM-U** (also known as Soft palate inclination Angle) - the angle formed by the lines PM-U and NL (°);
- distance **PM-U** (also known as Soft palate length) - distance between points PM and U (mm);
- distance **SPT** (also known as Maximum soft palate thickness) - the distance between the most distant points perpendicular to the line PM-U (mm);
- area **SPA** (also known as Soft palate area) - outlined by a contour through the points PM and U (mm<sup>2</sup>).

*Characteristics of the hyoid bone:*

- distance **AH-CV** (also known as Horizontal position of the hyoid) - distance between points AH and CV (mm);
- distance **AH-FH** (also known as Vertical position of the hyoid with respect to the Frankfort plane) - distance between points AH and FH (mm);
- distance **AH-MP** (also known as Vertical position of the hyoid with respect to the mandible) - distance between points AH and MP (mm).

*Characteristics of the tongue:*

- distance **H-VT** (also known as Height of the tongue) - distance between points H and VT (mm);
- distance **VT** (also known as Length of the tongue) - distance between points V and T (mm);
- area **TA** (also known as Tongue area) - outlined by a contour through the points T - H - TB - V - Ge - T (mm<sup>2</sup>).

The assessment of correlations between cephalometric indicators of the upper respiratory tract was carried out in the license package "Statistica 6.0" using non-parametric statistics of Spearman.

## Results

Table 1 presents the results of correlations between cephalometric indicators of the upper respiratory tract of Ukrainian YM with an orthognathic bite and the absence of pathology of the upper respiratory tract.

Table 2 presents the results of correlations between cephalometric indicators of the upper respiratory tract of Ukrainian YW with an orthognathic bite and the absence of pathology of the upper respiratory tract.

**Table 1.** Correlations between cephalometric indicators of the upper respiratory tract in Ukrainian YM (n=49).

	PASmin	PM-UPW	U-MPW	V-LPW	UAA	NL/PM-U	PM-U	SPT	SPA	AH-CV	AH-FH	AH-MP	H-VT	VT
PM-UPW	0.32													
U-MPW	0.72	0.36												
V-LPW	0.76	0.27	0.43											
UAA	0.81	0.48	0.75	0.65										
NL/PM-U	-0.22	-0.34	-0.20	-0.24	-0.12									
PM-U	0.04	-0.02	-0.14	0.16	0.06	0.07								
SPT	-0.43	0.12	-0.23	-0.24	-0.49	-0.14	0.02							
SPA	-0.29	0.10	-0.22	-0.13	-0.37	-0.10	0.46	0.83						
AH-CV	0.52	0.13	0.46	0.55	0.30	-0.29	0.11	-0.01	0.05					
AH-FH	-0.16	-0.23	-0.17	0.02	0.13	0.15	0.15	-0.20	-0.15	-0.21				
AH-MP	-0.01	-0.17	-0.04	0.01	0.25	0.18	0.12	-0.24	-0.14	-0.21	0.68			
H-VT	-0.05	-0.14	-0.25	0.13	0.00	0.13	0.17	-0.16	-0.18	-0.21	0.30	-0.13		
VT	0.34	0.11	0.33	0.24	0.38	-0.38	0.29	-0.07	0.07	0.31	0.17	0.50	-0.28	
TA	0.22	0.15	0.07	0.40	0.33	-0.33	0.40	-0.13	-0.04	0.20	0.18	0.07	0.41	0.47

**Notes:** here and in the following table, yellow background - reliable weak direct correlations; brown background - reliable medium-strength direct correlations; red background - reliable strong direct correlations; green background - reliable weak feedback correlations; blue background - reliable feedbacks correlations of medium strength.

**Table 2.** Correlations between cephalometric indicators of the upper respiratory tract in Ukrainian YW (n=76).

	PASmin	PM-UPW	U-MPW	V-LPW	UAA	NL/PM-U	PM-U	SPT	SPA	AH-CV	AH-FH	AH-MP	H-VT	VT
PM-UPW	0.34													
U-MPW	0.57	0.46												
V-LPW	0.69	0.33	0.44											
UAA	0.73	0.54	0.69	0.70										
NL/PM-U	-0.14	-0.42	-0.09	-0.18	-0.10									
PM-U	-0.04	0.22	-0.19	0.12	0.21	-0.18								
SPT	0.16	0.37	0.17	0.02	0.06	-0.30	0.11							
SPA	0.22	0.39	0.06	0.09	0.14	-0.40	0.45	0.85						
AH-CV	0.39	0.17	0.40	0.55	0.37	-0.10	0.08	0.10	0.09					
AH-FH	-0.14	-0.34	-0.20	0.18	0.13	0.19	0.27	-0.28	-0.12	0.12				
AH-MP	0.01	-0.19	0.01	0.16	0.22	0.01	0.25	-0.03	0.03	0.01	0.62			
H-VT	-0.16	-0.10	-0.23	0.12	0.00	0.19	0.15	-0.22	-0.12	0.07	0.42	0.01		
VT	0.14	0.15	0.15	0.13	0.28	-0.48	0.38	0.13	0.33	0.16	0.28	0.45	-0.17	
TA	-0.14	0.03	-0.11	0.18	0.08	-0.21	0.43	-0.04	0.14	0.20	0.37	0.05	0.69	0.29

In the analysis of reliable correlations between the cephalometric characteristics of the upper respiratory tract of Ukrainian YM with an orthognathic bite, multiple direct correlations of medium strength ( $r=$  from 0.32 to 0.48) and strong ( $r=$  from 0.65 to 0.81) correlations of the PASmin distance and the UAA area with all other cephalometric indicators of the upper respiratory tract, as well as the distances PM-UPW, U-MPW and V-LPW with most of the cephalometric indicators of the upper respiratory tract. The conducted quantitative analysis of reliable correlations between cephalometric characteristics of the upper

respiratory tract itself revealed 9 reliable connections out of 10 possible (90.00 %), of which 40.00 % were direct of medium strength, 50.00 % of direct strong.

In the analysis of reliable correlations between the cephalometric characteristics of the soft palate of Ukrainian YM with an orthognathic bite, the multiple nature and direct correlations were established only between the size of the SPA area and all distances of the soft palate ( $r=$ 0.46 and 0.83). The conducted quantitative analysis of reliable correlations between cephalometric characteristics of the soft palate revealed 2 connections out of 6 possible

(33.33 %), of which 16.67 % were direct of medium strength, 16.67 % of direct strong.

When analyzing reliable correlations between the *cephalometric characteristics of the hyoid bone* of Ukrainian YM with an orthognathic bite, only a *direct strong* ( $r=0.68$ ) correlation between the AH-FH and AH-MR distances was established, which is 33.33 % of the 3 possible relationships.

When analyzing reliable correlations between the *cephalometric characteristics of the tongue* of Ukrainian YM with an orthognathic bite, *multiple direct* ( $r=0.41$  and  $0.47$ ) correlations of the TA area with all tongue distances were established. The conducted *quantitative analysis* of reliable correlations between *cephalometric characteristics of the tongue* revealed 3 connections out of 3 possible (100 %), of which 66.67 % were direct of medium strength, 33.33 % were inverse of weak strength.

In the analysis of reliable correlations between the *cephalometric characteristics of the upper respiratory tract* and the soft palate of Ukrainian YM with an orthognathic bite, *multiple inverse correlations of mostly medium strength* ( $r=$  from  $-0.37$  to  $-0.49$ ) of the PASmin distance and the UAA area with the SPT distance were established and SPA areas. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the soft palate* of Ukrainian YM with an orthognathic bite revealed 5 correlations out of 20 possible (25.00 %), of which 5.00 % were inverse of weak strength, 20.00 % were inverse of medium strength.

When analyzing reliable correlations between the *cephalometric characteristics of the upper respiratory tract proper and the hyoid bone* of Ukrainian YM with an orthognathic bite, *multiple straight average strength* ( $r=$  from  $0.30$  to  $0.55$ ) correlations were established only between the value of the AH-CV distance and most of the cephalometric characteristics of the upper proper airway respiratory tract. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the hyoid bone* of Ukrainian YM with an orthognathic bite revealed 4 connections out of 15 possible (26.67 %), all of which are direct of medium strength.

When analyzing reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the tongue* of Ukrainian YM with an orthognathic bite, *multiple direct correlations of medium strength* ( $r=$  from  $0.33$  to  $0.40$ ) were established only between the value of the VT distance and more than half of the cephalometric characteristics of the proper upper respiratory tract. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the tongue* of Ukrainian YM with an orthognathic bite revealed 5 relationships out of 15 possible (33.33 %), all of which are direct of medium strength.

In the analysis of reliable correlations between the *cephalometric characteristics of the soft palate and hyoid bone* of Ukrainian YM with orthognathic bite, no multiple correlations were established. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the soft palate and hyoid bone* of Ukrainian YM with an orthognathic bite revealed only 1 inverse weak strength correlation out of 12 possible (8.33 %).

In the analysis of reliable correlations between the *cephalometric characteristics of the soft palate and the tongue* of Ukrainian YM with an orthognathic bite, *multiple inverse correlations of the average strength* ( $r=-0.33$  and  $-0.38$ ) of the NL/PM-U angle and most tongue characteristics were established, as well as *direct weak and medium strength* ( $r=0.29$  and  $0.40$ ) correlations between the value of the PM-U distance and most characteristics of the tongue. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the soft palate and tongue* of Ukrainian YM with an orthognathic bite revealed 4 connections out of 12 possible (33.33 %), of which 8.33 % were direct of weak strength, 8.33 % were direct of medium strength, and 16.67 % were inverse medium strength.

In the analysis of reliable correlations between the *cephalometric characteristics of the hyoid bone and the tongue* of Ukrainian YM with an orthognathic bite, *multiple direct correlations of medium strength* ( $r=0.31$  and  $0.50$ ) were established only between the value of the VT distance and most of the cephalometric characteristics of the hyoid bone. The *quantitative analysis* of reliable correlations between the *characteristics of the hyoid bone and the tongue* of Ukrainian YM with an orthognathic bite revealed 3 average direct strength correlations out of 9 possible (33.33 %).

When analyzing reliable correlations between the *cephalometric characteristics of the upper respiratory tract* of Ukrainian YW with an orthognathic bite, *multiple direct relationships of medium strength* ( $r=$  from  $0.34$  to  $0.57$ ) and *strong* ( $r=$  from  $0.69$  to  $0.73$ ) correlations between all cephalometric indicators were established. The conducted *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the upper respiratory tract itself* revealed 10 connections out of 10 possible (100 %), of which 60.00 % were direct of medium strength, 40.00 % were direct strong.

In the analysis of reliable correlations between the *cephalometric characteristics of the soft palate* of Ukrainian YW with an orthognathic bite, *multiple inverse* ( $r=-0.30$  and  $-0.40$ ) correlations of *average strength* were established between the value of the NL/PM-U angle and the value of the SPT distance and the SPA area, and as well as *medium strength* ( $r=0.45$ ) and *strong* ( $r=0.85$ ) direct correlations between the size of the SPA area and the PM-U and SPT distances. The conducted *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the soft palate* revealed 4 connections out of 6 possible

(66.67 %), of which 16.67 % were direct of average strength, 16.67 % were direct strong, and 33.33 % were inverse of average strength.

When analyzing reliable correlations between the *cephalometric characteristics of the hyoid bone* of Ukrainian YW with an orthognathic bite, as in young men, only a *direct strong* ( $r=0.62$ ) correlation was established between the AH-FH and AH-MR distances, which of the 3 possible correlations is 33.33 %.

In the analysis of reliable correlations between the *cephalometric characteristics of the tongue* of Ukrainian YW with an orthognathic bite, *straight weak* ( $r=0.29$ ) and *strong* ( $r=0.69$ ) correlations of the size of the TA area with all tongue distances were established. The conducted *quantitative analysis* of reliable correlations between *cephalometric characteristics of the tongue* revealed 2 connections out of 3 possible (66.67 %), of which 33.33 % were direct weak and 33.33 % were direct strong.

When analyzing reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the soft palate* of Ukrainian YW with an orthognathic bite, *multiple medium-strength direct* ( $r=0.37$  and  $0.39$ ) and *inverse* ( $r=-0.42$ ) correlations were established between the value of the PM-UPW distance and the magnitude of the SPT distance, the SPA section, and the NL/PM-U angle. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the upper respiratory tract proper and the soft palate* of Ukrainian YW with an orthognathic bite revealed 3 correlations out of 20 possible (15.00 %), of which 10.00 % were direct of average strength, 5.00 % were inverse of average strength.

When analyzing reliable correlations between the *cephalometric characteristics of the upper respiratory tract proper and the hyoid bone* of Ukrainian YW with an orthognathic bite, *multiple straight of average strength* ( $r$ = from 0.37 to 0.55) correlations were established only between the value of the AH-CV distance and most of the cephalometric characteristics of the upper proper airway respiratory tract. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the upper respiratory tract and the hyoid bone* of Ukrainian YW with an orthognathic bite revealed 5 correlations out of 15 possible (33.33 %), of which 26.67 % were direct of average strength, 6.67 % were inverse of average strength.

When analyzing reliable correlations between the *cephalometric characteristics of the proper upper respiratory tract and the tongue* of Ukrainian YW with orthognathic bite, no multiple correlations were established. The conducted *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the upper respiratory tract and the tongue* of Ukrainian YW with an orthognathic bite revealed 2 connections out of 15 possible (13.33 %), of which 6.67 % were direct of weak strength, 6.67 % were reverse of weak strength.

When analyzing reliable correlations between the

*cephalometric characteristics of the soft palate and hyoid bone* of Ukrainian YW with an orthognathic bite, *multiple weak direct* ( $r=0.25$  and  $0.27$ ) correlations were established between the value of the PM-U distance and the value of the AH-FH and AH-MP distances. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the soft palate and hyoid bone* of Ukrainian YW with an orthognathic bite revealed 3 correlations out of 12 possible (25.00 %), of which 16.67 % were direct of weak strength, 8.33 % were reverse of weak strength.

In the analysis of reliable correlations between the *cephalometric characteristics of the soft palate and tongue* of Ukrainian YW with an orthognathic bite, *multiple direct* ( $r=0.38$  and  $0.43$ ) correlations between the value of the PM-U distance and the value of the VT distance and the TA area, as well as the average strength of direct ( $r=0.33$  and  $0.38$ ) and average strength of inverse ( $r=-0.48$ ) correlations between the value of the VT distance and most of the characteristics of the soft palate. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the soft palate and tongue* of Ukrainian YW with an orthognathic bite revealed 4 relationships out of 12 possible (33.33 %), of which 25.00 % were direct of average strength, 8.33 % were inverse of average strength.

When analyzing the reliable correlations between the *cephalometric characteristics of the hyoid bone and the tongue* of Ukrainian YW with an orthognathic bite, multiple direct ( $r=0.37$  and  $0.42$ ) correlations between the AH-FH distance and all characteristics of the tongue were established. The *quantitative analysis* of reliable correlations between the *cephalometric characteristics of the hyoid bone and the tongue* of Ukrainian YW with an orthognathic bite revealed 4 connections out of 9 possible (44.44 %), of which 11.11 % were direct of weak strength, 33.33 % were direct of medium strength.

## Discussion

Thus, in Ukrainian YM and YW with an orthognathic bite and the absence of pathology of the upper respiratory tract, when analyzing reliable correlations between the cephalometric indicators of the upper respiratory tract itself, the soft palate, hyoid bone, and the tongue, manifestations of sexual dimorphism of correlations, which are most pronounced between the cephalometric characteristics of the soft palate, between the cephalometric characteristics of the upper respiratory tract proper and the soft palate, between the cephalometric characteristics of the upper respiratory tract proper and the tongue, as well as between the cephalometric characteristics of the soft palate and the hyoid bone.

The results of our research fit quite well into the trends seen in numerous international publications related to the study of the relationships of the upper respiratory tract and cephalometric indicators.

Comparison of cephalometric indicators in individuals of skeletal classes I and II with normal facial types showed

that representatives of class II had smaller values of pharynx volume, airway area, and MCA ( $p < 0.01$ ,  $p = 0.03$ , and  $p = 0.008$ , respectively) and a shorter distance U-MS ( $p < 0.001$ ). Airway volume and area have a significant positive correlation with the U-MS distance ( $r = 0.22$ ,  $p = 0.005$  and  $r = 0.28$ ,  $p < 0.005$  respectively) and a negative correlation with the ANB angle ( $r = -0.23$ ,  $p = 0.002$  and  $r = -0.21$ ,  $p = 0.007$  respectively) [10].

Comparison of data from individuals of all three skeletal classes shows significant differences in the depth of the lower pharyngeal and nasopharyngeal airways and the area of the soft palate. At the same time, both horizontal and vertical dimensions are larger in men than in women [13].

When evaluating the indicators of the respiratory tract of patients with II skeletal malocclusion class divided into three subgroups, the researchers did not find any significant differences between the subgroups ( $p > 0.05$ ). However, after adding the hyoid bone position assessment parameter, a statistically significant difference between Hy-PG measurements was found ( $p < 0.05$ ) [4]. Taking into account the position of the hyoid bone is indeed an important element in the analysis of respiratory tract indicators. In the next study, when working with patients with class III malocclusion, the authors found significant differences between the studied subgroups for Hy-A, Hy-S, Hy-SN and Hy-FH indicators ( $p < 0.05$ ) [5]. The analysis of the results of our study shows that in individuals with an orthognathic bite there are reliable correlations between the respiratory tract and surrounding structures and cephalometric indicators.

At the same time, the data of some studies show that if we take into account the type of facial growth and the position of the hyoid bone, then there is no statistically significant difference in the studied indicators of the respiratory tract in the various studied groups, except for the PNS-EP indicator, which is significantly shorter in individuals with III skeletal class and hypodivergent face type ( $p < 0.05$ ) [16].

L. V. Claudino et al. [6] carried out a fundamental study on the establishment of normative indicators for each of the departments of the respiratory tract in persons with different types of facial skeletal class. As a result, it was found that individuals with class II had lower minimum and average values of all sections of the respiratory tract than representatives of class III. The most uniform morphology of the respiratory tract is characteristic of persons with the I and III skeletal class of the face.

Consideration of gender is key in the formation of any research samples. Cephalometric analysis of respiratory tract indicators shows the existence of significant differences for T-PPW, ANS-PNS, BA-PNS, APW2-PPW2 and HY-APW2 indicators ( $p < 0.05$ ) [24].

Taking into account the ethnic component in the study of the respiratory tract is mandatory, because the existence of differences in anthropometric indicators within different populations is a proven fact. On the example of the Lebanese population, significant differences were found

in 12 out of 19 analyzed cephalometric indicators. In particular, within the population, manifestations of sexual dimorphism were found for the size of the uvula and tongue, the distance from the back pharyngeal wall of the epiglottis (larger values in men) [9].

It is equally important to take into account the age of the examined persons. The use of lateral cephalograms to measure the morphology of the upper respiratory tract is a fairly sensitive and reliable method, however, at the same time, it is noted that the evaluation of the parameters of the tongue and soft palate has limited reliability [23].

From the point of view of various accompanying pathologies, data on cephalometric indicators of the respiratory tract are also important information. Analysis of data in children with different types of breathing showed that mouth-breathing children had significant differences from nose-breathing children for SNB ( $p < 0.036$ ), NSGN ( $p < 0.028$ ) and posterior face height/total anterior face height ratios ( $p < 0.012$ ) [11].

In the case of obstructive sleep apnea, there is a pronounced relationship between craniofacial disharmony and the presence of this disease. Among such parameters, heterogeneity is particularly evident in relation to ALFH, GO-H, Gogn-H, Gognng-H, PNS-PHW and pharynx area [17].

Domestic studies on the relationship of cranial and other surrounding structures depending on the types of face are single, and so far aimed at studying the relationship with dental and jaw indicators [18].

At the same time, it is worth paying attention to the existence of works that show the influence of the type of face on the parameters of the respiratory tract. In persons with average faces and skeletal class II there was reduced glossopharyngeal airway volume and at the same time there was found that persons with long faces have higher values of nasal minimum constricted area [2].

G. Acharya with co-authors [1] using the analysis of 210 lateral cephalograms according to the McNamara method, they established the average values of the width of the upper and lower respiratory tracts in persons belonging to different skeletal classes and facial shapes, namely 12.07 and 9.51 mm in persons of the I class, 11.57 and 9.13 mm - II class, 12.34 and 10.03 mm - III class and 12.35 and 9.62 mm in mesofacials, 11.83 and 9.34 mm in dolichofacials and 11.81 and 9.61 mm in brachyfacials. The average values were higher in men, which confirms the manifestations of sexual dimorphism that we discovered.

In this regard, it is necessary to carry out further research aimed specifically at studying this interaction, but with the parameters of the respiratory tract and the inclusion of such a parameter as face types in the sample.

## Conclusion

1. In Ukrainian YM with an orthognathic bite and the absence of pathology of the upper respiratory tract, multiple mostly direct correlations of medium strength ( $r =$  from

0.32 to 0.48) and strong ( $r =$  from 0.65 to 0.83) were established between most of the cephalometric characteristics of the upper respiratory tract itself (90.00 %) or tongue (100 %); in YW, there are also mostly direct medium-strength ( $r =$  from 0.33 to 0.57) and strong ( $r =$  from 0.62 to 0.85) correlations between the majority of cephalometric characteristics of the upper respiratory tract itself (100 %) or the tongue (66.67 %), as well as medium strength inverse ( $r = -0.30$  and  $-0.40$ ) and direct ( $r = 0.45$  and  $0.85$ ) correlations between most cephalometric characteristics of the soft palate (66.67 %).

2. In Ukrainian YM with an orthognathic bite and the absence of pathology of the upper respiratory tract, multiple inverse correlations of mainly medium strength ( $r =$  from  $-0.33$  to  $-0.49$ ) of the PASmin distance and the UAA area with the SPT distance and the SPA area were established (25.00 %) and between the value of the NL/PM-U angle and most of the characteristics of the tongue (16.67 %), as well as multiple direct, mostly medium-strength ( $r =$  from

0.30 to 0.55) correlations between the cephalometric characteristics of the upper respiratory tract itself and the hyoid bone (26.67 %) or tongue (33.33 %) and between the cephalometric characteristics of the hyoid bone and tongue (33.33 %); in YW, there are mostly straight of medium strength ( $r =$  from 0.33 to 0.55) correlations between the value of the AH-CV distance and most of the cephalometric characteristics of the upper respiratory tract itself (26.67 %), between the value of the AH-FH distance and all characteristics of the tongue (33.33 %) and between the value of the distance PM-U and the value of the distance VT and the TA section (16.67 %).

3. The most pronounced manifestations of sexual dimorphism of connections are established between the cephalometric characteristics of the soft palate, between the cephalometric characteristics of the upper respiratory tract itself and the soft palate or tongue, as well as between the cephalometric characteristics of the soft palate and the hyoid bone.

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#### ОСОБЛИВОСТІ КОРЕЛЯЦІЙ ЦЕФАЛОМЕТРИЧНИХ ПАРАМЕТРІВ ВЕРХНІХ ДИХАЛЬНИХ ШЛЯХІВ В УКРАЇНСЬКИХ ЮНАКІВ І ДІВЧАТ БЕЗ УРАХУВАННЯ ТИПУ ОБЛИЧЧЯ

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Дослідження параметрів верхніх дихальних шляхів стало одним з провідних напрямків медичних досліджень, у зв'язку з пов'язаністю даної структури з виникненням та перебігом багатьох захворювань як дитячого, так і дорослого віку. Вивчення нормативних показників даної структури та її зв'язку з краніометричними показниками має бути першим кроком перед подальшим дослідженням вибірок з патологіями. Мета дослідження - встановлення особливостей кореляцій цефалометричних параметрів верхніх дихальних шляхів в українських юнаків і дівчат із ортогнатичним прикусом без ураження типу обличчя. На первинних бокових телерентгенограмах 49 українських юнаків (віком від 17 до 21 років) і 76 українських дівчат (віком від 16 до 20 років) із ортогнатичним прикусом і відсутністю патології верхніх дихальних шляхів, які взяті з бази даних науково-дослідного центру та кафедри стоматології дитячого віку Вінницького національного медичного університету ім. М. І. Пирогова, за допомогою ліцензованого медичного програмного забезпечення *ОпухСерп™*, версії *3DPro* (компанії *Image Instruments GmbH*, Німеччина) та діагностичної програми *"UniqСерп"* проведений цефалометричний аналіз верхніх дихальних шляхів. У ліцензійному пакеті *"Statistica 6.0"* проведено оцінку кореляцій між цефалометричними показниками верхніх дихальних шляхів за допомогою непараметричної статистики Спірмена. В українських юнаків встановлені множинні переважно прямі середньої сили ( $r =$  від 0,32 до 0,48) та сильні ( $r =$  від 0,65 до 0,83) зв'язки між більшістю характеристик власно верхніх дихальних шляхів або язика; у дівчат - також переважно прямі середньої сили ( $r =$  від 0,33 до 0,57) та сильні ( $r =$  від 0,62 до 0,85) зв'язки між більшістю характеристик власно верхніх дихальних шляхів або язика, а також середньої сили зворотні ( $r = -0,30$  і  $-0,40$ ) та прямі ( $r = 0,45$  і  $0,85$ ) зв'язки між більшістю характеристик м'якого піднебіння. Крім того, в українських юнаків встановлені множинні зворотні переважно середньої сили ( $r =$  від  $-0,33$  до  $-0,49$ ) зв'язки величини відстані *PASmin* і ділянки *UAA* з величиною відстані *SPT* і ділянки *SPA* та між величиною кута *NL/PM-U* та більшістю характеристик язика, а також множинні прямі, переважно середньої сили ( $r =$  від 0,30 до 0,55), зв'язки між характеристиками власно верхніх дихальних шляхів і під'язикової кістки або язика та між характеристиками під'язикової кістки та язика; у дівчат - переважно прямі середньої сили ( $r =$  від 0,33 до 0,55) зв'язки між величиною відстані *AN-CV* та більшістю характеристик власно верхніх дихальних шляхів, між величиною відстані *AN-FH* й усіма характеристиками язика та між величиною відстані *PM-U* та величиною відстані *VT* і ділянки *TA*. Таким чином, найбільш виражені прояви статевого диморфізму зв'язків встановлені між характеристиками м'якого піднебіння, між характеристиками власно верхніх дихальних шляхів та м'якого піднебіння або язика, а також між характеристиками м'якого піднебіння та під'язикової кістки.

**Ключові слова:** цефалометрія, кореляції, верхні дихальні шляхи, м'яке піднебіння, під'язикова кістка, язик, українські юнаки та дівчата, ортогнатичний прикус, статевий диморфізм.