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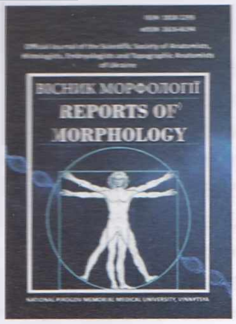

Regression models of parameters required for constructing an appropriate dental arch form depending on the characteristics of teleroentgenometric indices by the Schwarz method and computed tomographic tooth dimensions in Ukrainian young men and women with normal occlusion

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Malocclusions and discrepancies in dental arch form remain highly prevalent among children and adolescents worldwide, significantly affecting oral health, facial aesthetics and quality of life. Accurate, population-specific prediction of individual dental arch parameters based on cephalometric and odontometric characteristics is therefore essential for personalized planning of orthodontic and orthognathic treatment in young patients with normal occlusion. The aim of the study is to construct and analyze regression models of the dimensions required for constructing the correct dental arch form in Ukrainian young men and women with physiological occlusion depending on teleroentgenometric indices according to the Schwarz method and computed-tomographic tooth dimensions. In the OnyxCeph³™ application, 3DPro version (Image Instruments GmbH, Germany) teleroentgenometric indices according to the Schwarz method were performed on conventionally obtained lateral teleroentgenograms and on teleroentgenograms created in the 3D Slicer v5.4.0 software with points marked on 3D objects in 41 Ukrainian young men and 68 young women with physiological occlusion. Also, in these young men and women, using the software applications i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor and Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY, measurements of the dimensions of the teeth of the maxilla and mandible and the linear parameters of the dental arches were performed on computed tomograms. Using the licensed software package "Statistica 6.0" regression models were constructed for the parameters of the correct dental arch form depending on the characteristics of the cephalometric parameters and computed-tomographic tooth dimensions. It was established that in young men all 18 possible significant models with a coefficient of determination greater than 0.6 were constructed (R2=0.680-0.893, p<0.001); and in young women only 6 significant models with a coefficient of determination greater than 0.6 were constructed (R2=0.611-0.800, p<0.001). In the analysis of the frequency with which computed-tomographic tooth dimensions and teleroentgenometric indices entered the regression equations it was established: in young men the variables most frequently included in the models are crown width in the vestibulo-oral and mesio-distal planes, cephalometric parameters and tooth length; and in young women cephalometric parameters and crown width in the mesio-distal and vestibulo-oral planes. In the analysis of the frequency with which individual teeth entered the regression equations it was established that in young men the teeth most frequently included in the models are maxillary incisors, mandibular incisors, maxillary premolars, mandibular premolars and maxillary canines; and in young women maxillary incisors, mandibular incisors, mandibular canines and mandibular premolars.

Keywords: *dentistry, teleroentgenometry by the Schwarz method, computed tomographic dimensions of teeth and dental arches, regression analysis, Ukrainian young men and women with normal occlusion.*

Introduction

Pathology of the dentoalveolar system occupies one of the leading positions in the structure of dental morbidity in children, and its incidence tends to increase in most countries. The global distribution of the main occlusal classes in permanent dentition is approximately 74.7 % for class I, 19.6 % for class II and 5.9 % for class III, as reported by Alhammadi M. S. et al., which demonstrates that the overall burden of malocclusion is high [3]. Another systematic review on the prevalence of malocclusion in children and adolescents revealed that the proportion of individuals with various types of malocclusion generally ranges from about 40 % to more than 90 % in different regions, which indicates not only extremely high variability but also the mass character of this pathology as a worldwide public health problem [8].

Regional studies corroborate the high prevalence of malocclusions in schoolchildren in countries with diverse socio-economic conditions. A high prevalence of malocclusions and a high percentage of children in need of orthodontic treatment have been recorded in the northern regions of Saudi Arabia, which is attributed both to the characteristics of craniofacial growth and to limited access to specialized services [1]. Studies in Turkey and in major cities of China (Shanghai, Xi'an) have demonstrated that various types of malocclusion are found in a significant proportion of children aged 10-12 years and in the mixed dentition stage, with the structure of anomalies differing considerably according to age, sex and place of residence [4, 29, 30].

In view of their high prevalence, malocclusions have not only medical but also pronounced social and psycho-emotional importance, affecting the quality of life of children and adolescents. Brazilian studies have shown an association between orthodontic treatment need and oral health-related quality of life, demonstrating that a considerable number of adolescents require some type of orthodontic treatment according to public health criteria, and that the presence of severe dentoalveolar anomalies is related to worse OHRQoL, impaired self-esteem and reduced satisfaction with appearance [7]. In a study of 8-12-year-old schoolchildren it was demonstrated that the presence of moderate and severe malocclusion has a significant negative impact on functional aspects and on emotional and social well-being related to oral health, which supports the societal benefits of early orthodontic intervention at an age when disturbances in dental arch form can be detected and corrected [28].

The morphology and shape of the dental arches are key components in the development of occlusal relationships and in maintaining stability after orthodontic treatment. Recent studies indicate that children with normal occlusion and those with various types of malocclusion differ significantly in dental arch form and dimensions, and that deviations of transversal and sagittal arch parameters are associated with the development of dentoalveolar anomalies [12]. Certain groups of patients, for example children with cleft lip and/or palate, show marked changes in dentoalveolar arch morphology and a high percentage of anomalies in the position and shape of individual teeth, which emphasi: role of individual dental arch parameters in the develc of complex dentoalveolar conditions [24].

Despite a wide range of studies on the prev of malocclusion and its impact on quality of life, s important issues remain insufficiently resolved, inc the quantitative description of dental arch form a construction of regression models aimed at linking characteristics of the dentitions with cephalometri and odontometric indices, especially in adolescents probable reason is that most existing studies on di types of anomalies focus primarily on the frequenc qualitative characteristics of malocclusion types and consider individual craniofacial morphology or spatial dimensions, although precisely these approaches potentially be used to predict the optimal dental arch and to individualize orthodontic care. Given the globa local significance of dentoalveolar pathology and its p relationship with arch morphology, which contributes formation of malocclusions, research on regression m of parameters necessary for designing an adequate c arch form in healthy young men and women with n occlusion acquires scientific and practical relevance [3, 8

The aim of the study is to construct and analyze regre models of the dimensions required for constructin correct dental arch form in Ukrainian young men and wo with physiological occlusion depending on cephalon parameters according to the Schwarz method computed-tomographic tooth dimensions.

Materials and methods

From the database of the Department of Pedi Dentistry and the Research Center of National Pir Memorial Medical University, Vinnytsya primary comp tomograms of 41 Ukrainian young men (aged from 1 21 years) and 68 Ukrainian young women (aged fror to 20 years) with physiological occlusion were obtai All teleroentgenographic (using the dental cone-b tomograph Veraviewepocs 3D Morita, Japan) and compu tomographic (using the dental cone-beam tomogr Planmeca ProMax 3D Mid, Finland) examinations w carried out on the basis of the principle of volun informed consent in the private dental clinic "Vinintern and in the "Center for Maxillofacial Diagnostics Planm 3D". Committee on Bioethics of National Pirogov Mem Medical University, Vinnytsya (protocol № 8 From 9.09.2 found that the studies do not contradict the basic bioeth standards of the Declaration of Helsinki, the Counc Europe Convention on Human Rights and Biomedic (1977), the relevant WHO regulations and laws of Ukra

On conventionally obtained lateral cephalograms cephalograms created in the 3D Slicer v5.4.0 software points marked on 3D objects, measurements accordin the method of Schwarz A. M. [26, 27] were performed in OnyxCeph³™ application, 3DPro version, Image Instrume GmbH (Germany).

In accordance with the Schwarz method the following craniometric (Fig. 1), gnathometric indices (Figs. 2, 3) and soft tissue profile indices (Fig. 4) were determined: angle **F** (°) – facial angle, formed by the lines Se-N and N-A and defining the position of the anterior contour of the maxilla in the sagittal plane relative to the cranial base; angle **H** (°) – the angle formed by the lines Po-Or (Frankfurt plane (Fp)) and Pn ((nasal perpendicular, the perpendicular line from point N' (cutaneous nasion) to the line Se-N)), defining the inclination of the Frankfurt plane to the cranial base; angle **I** (°) – inclination angle, defining the angle of inclination of the maxilla (spinal plane) to the nasal perpendicular, the angle formed by the line ANS-PNS and Pn (nasal perpendicular, the perpendicular line from point N' to the line Se-N); angle **T** (°) – profile angle T, formed by the lines Sn-Pog' and Pn (nasal perpendicular); angle **B** (°) – basal angle, indicating the angle between the maxilla and mandible, formed by the lines ANS-PNS (palatal plane SpP) and Im-Me (mandibular plane MPS according to Schwarz); distance **N-Se** (mm) – distance from point Se to point N, or the length of the anterior part of the cranial base; distance **Max** (mm) – maxillary length, the distance from the projection of point A onto the line ANS-PNS to point PNS; angle **Max1-SpP** (°) – formed by the lines Ap1u-Is1u (inclination of the central axis of the maxillary central incisor) and ANS-PNS (palatal plane, SpP); angle **II** (°) – interincisal angle, formed by the lines Ap1u-Is1u (central axis of the maxillary central incisor) and Ap1L-Is1L (central axis of the mandibular central incisor); angle **G** (°) – gonial angle, mandibular angle, formed by the lines ppCond-MT2 and MT1-Me, which intersect at point tGoS; distance **L-Mand** (length of mandible) (mm) – mandibular length; the distance from the projection of point Pog onto the line MT1-Me to point tGoS; distance **R.asc.** (mm) – ramus length; the distance from the constructed point R.asc to the constructed point tGoS; angle **Mand1-MP** (°) – formed by the lines Ap1L-Is1L and Me-Im and defining the position of the axes of the mandibular incisors relative to the mandibular plane according to Schwarz; angle **MM** (°) – maxillo-mandibular angle, defining the angle at which the maxilla is positioned relative to the mandible in the sagittal plane, formed by the lines A-B and ANS-PNS; distance **Sn-Pn** (mm) – defining the position of point Sn relative to the perpendicular Pn; distance **Pog'-Por** (mm) – distance from point Pog' to the orbital perpendicular Por, defining the position of the chin relative to the perpendicular to the Frankfurt plane drawn through the orbit; angle **Gl'LsPog'** (°) – formed by the lines Gl'-Ls and LsPog', defining facial convexity; angle **SnPog'-Pn** (°) – formed by the lines SnPog' and the perpendicular Pn; distance **Li-SnPog'** (mm) – defining the position of point Li relative to the line SnPog'.

For the morphometric study of the teeth of the maxilla and mandible and the dimensions of the dental arches the software applications i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor and Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY were used.

For the anterior group of teeth, namely for the incisors and canines of the maxilla and mandible, crown width and the width of the dentinoenamel junction of the tooth were determined in

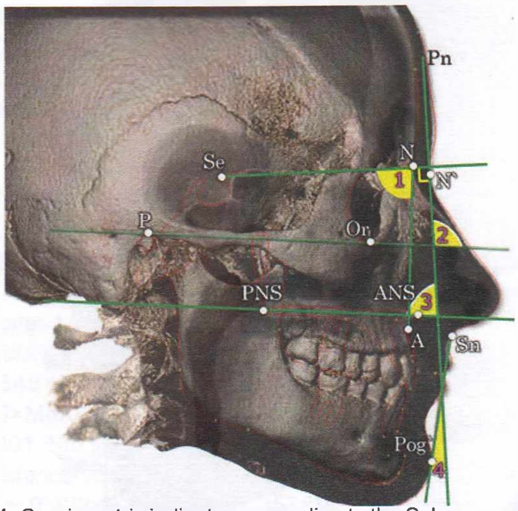

Fig. 1. Craniometric indicators according to the Schwarz method. 1 – angle F, 2 – angle H, 3 – angle I, 4 – angle T.

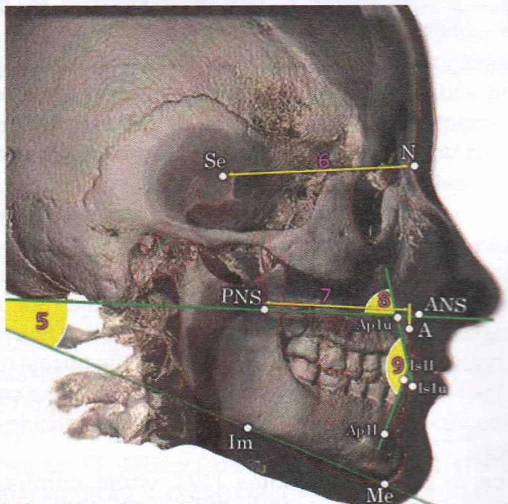

Fig. 2. Gnathometric indicators according to the Schwarz method. 5 – angle B, 6 – distance N-Se, 7 – distance Max. 8 – angle Max1-SpP, 9 – angle II.

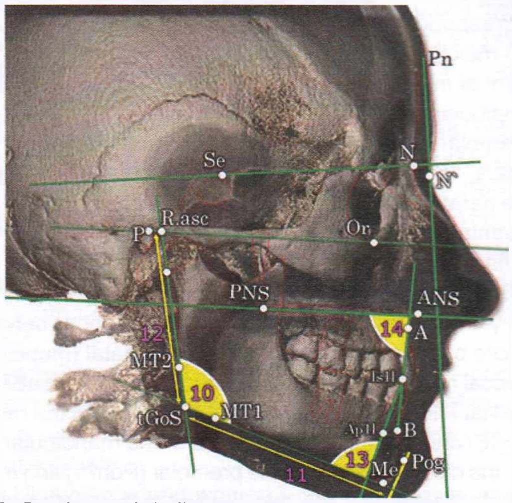

Fig. 3. Gnathometric indicators according to the Schwarz method. 10 – angle G, 11 – distance L-Mand, 12 – distance R.asc., 13 – angle Mand1-MP, 14 – angle MM

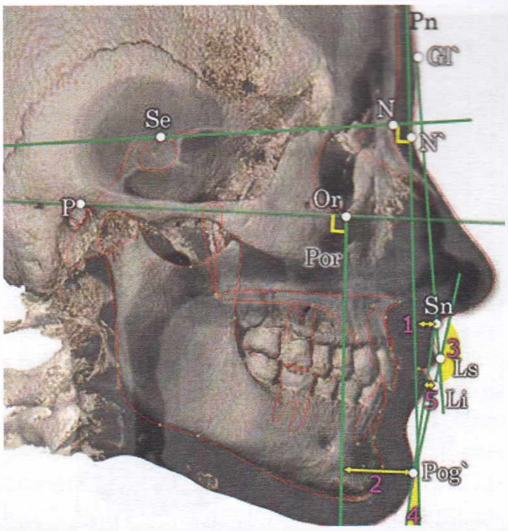

Fig. 4. Soft tissue profile indicators according to the Schwarz method. 1– Sn-Pn distance; 2 – Pog'-Por distance; 3 – Gl'LsPog' angle; 4 – SnPog'-Pn angle; 5 – Li-SnPog' distance.

the mesiodistal (MdK and MdC, respectively) and vestibulo-oral (VoK and VoC) projections, the length of the whole tooth (MdLD – identical in both projections), as well as crown height (MdLK and VoLK) and root length (MdLR and VoLR) relative to the cervical line in the corresponding projections.

For the premolars of the maxilla and mandible the crown width was determined in the mesiodistal and vestibulo-oral projections, as well as tooth length, which was measured between the cusp tip of the buccal cusp and the root apex in the vestibulo-oral projection (if the premolar had two roots tooth length was determined to the apex of the buccal root).

For the first molars of the maxilla and mandible the crown width was determined in the mesiodistal and vestibulo-oral projections.

Since in previous studies [17], when comparing computed-tomographic dimensions of corresponding teeth on the right and left sides, no significant differences or trends toward differences were found, we used mean values of the corresponding teeth in the maxilla and mandible: 11 or 41 – maxillary or mandibular central incisors, 12 or 42 – maxillary or mandibular lateral incisors, 13 or 43 – maxillary or mandibular canines, 14 or 44 – maxillary or mandibular first premolars, 15 or 45 – maxillary or mandibular second premolars, 16 or 46 – maxillary or mandibular first molars.

The parameters of the dental arches were determined in three cranial planes. In the axial plane the following distances were measured: between the cusp tips (13_23Bugr and 33_43Bugr) and root apices (13_23Apx and 33_43Apx) of the maxillary and mandibular canines (Fig. 5); distances between the apices of the mesiobuccal (mapx_6), palatal (mapex_6), distobuccal roots (dapx_6) and the buccal cusps (VestBM) of the maxillary first molars (Fig. 6) and the apices of the mesial (mapx_46) and distal (dapx_46) roots of the mandibular first molars; the distance between the premolar (PonPr) and molar (PonM) Pont's points in the maxilla, and in the sagittal plane the distances were measured between the incisal edges of the central incisors and the lines connecting the canine cusps (DL_C), the premolar (DL_F) and molar (DL_S) Pont's points in the maxilla (Fig. 7). In the vertical plane distances were measured that characterize the position of the occlusal plane at the level of the canines (GL_1), first premolars (GL_2) and molars (GL_3) relative to the hard palate (Fig. 8).

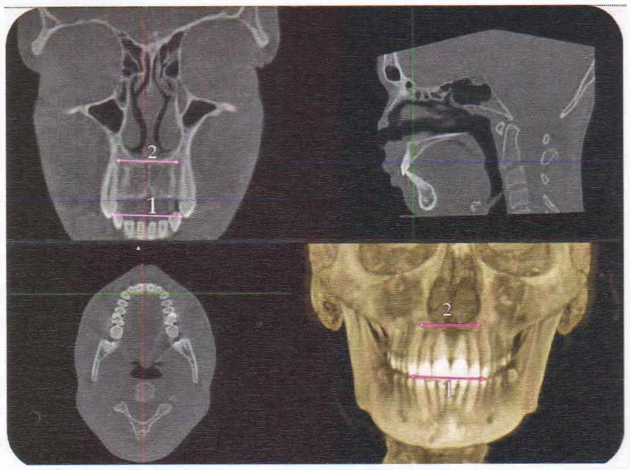

Fig. 5. Determination of the distance between the cusp tips (1) and root apices (2) of the maxillary canines.

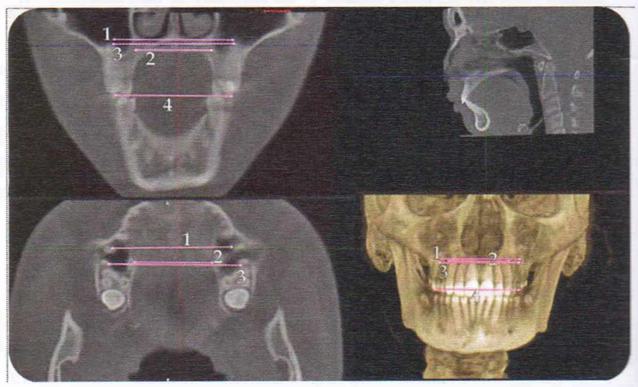

Fig. 6. Determination of the distances between the apices of the mesiobuccal (1), palatal (2) and distobuccal roots (3) and the buccal cusps (4) of the maxillary first molars.

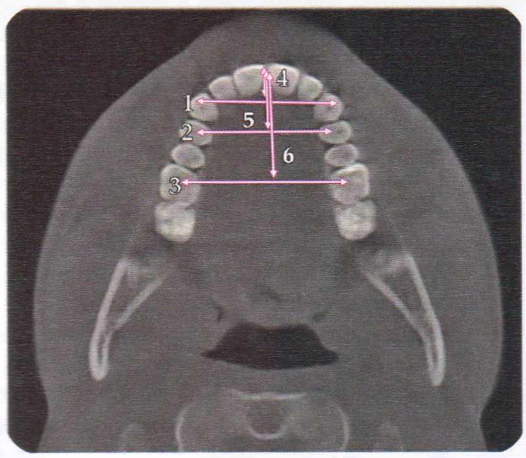

Fig. 7. Determination of the distances between the canine cusps (1), the premolar (2) and molar (3) Pont's points, and the distances between the incisal point and the canine (4), premolar (5) and molar (6) lines in the maxilla.

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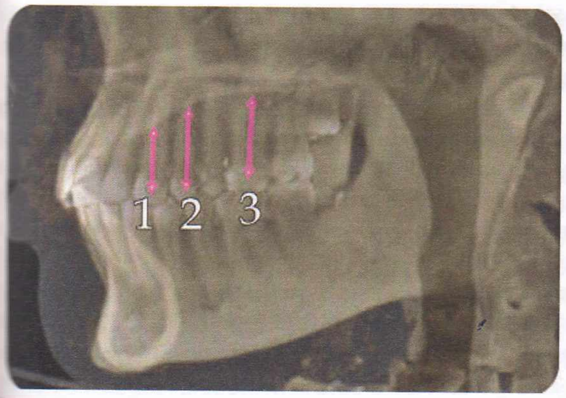

g. 8. Determination of the distances that characterize the ation of the occlusal plane relative to the hard palate at the el of the canine (1), premolar (2) and molar (3) lines.

Using the "Statistica 6.0" license package, regression dels were built (using the stepwise regression analysis hod) of the dental arch parameters depending on the aracteristics of teleradiometric indicators and computed ography dimensions of the teeth.

Results

n Ukrainian *young men* with physiological occlusion the wing significant regression models (with a coefficient of rmination R^2>0.60) of the linear dimensions required constructing the correct dental arch form depending on characteristics of cephalometric parameters according e Schwarz method and computed-tomographic tooth ensions were constructed:

stance DL_C (young men)= -14.89 + 0.814×MdK11 + 3×VoK41 + 0.081×MM - 0.403×VoLK41 + 0.744×MdC11 381MdLK13 - 0.155VoLR13 (R^2=0.849, $F_{(7.33)}$=26.45, 001, Std.Error of estimate=0.575);

stance DL_F (young men)= -9.443 + 1.570×MdK11 240×VoK15 - 0.381×VoLK42 - 0.590×VoK45 + 8×VoC42 - 0.323×MdLR42 + 0.166×MdLR41 + ×Gl'LsPog' (R^2=0.849, $F_{(8.32)}$=22.51, p<0.001, Std.Error mate=0.669);

stance DL_S (young men)= 6.145 + 1.905×MdK11 548×VoK15 + 0.861×VoK46 - 0.071×Mand1-MP - ×VoK45 - 0.336×MdLR12 + 0.370×VoK14 (R^2=0.893, =39.35, p<0.001, Std.Error of estimate=0.675);

stance GL_1 (young men)= 17.66 + 0.201×Max1-SpP 2×MdK46 + 1.333×VoK15 - 0.255×H + 0.122×Max + VoC42 - 0.581×MdLR12 + 0.325×MdLD13 (R^2=0.727, =10.63, p<0.001, Std.Error of estimate=1.417);

stance GL_2 (young men)= -2.572 + 0.173×Max1- + 0.683×VoLR13 - 0.980×MdLD45 + 2.864×VoK12 + MdLK13 - 0.654×MdLD41 + 0.477×MdLK11 (R^2=0.680, =10.00, p<0.001, Std.Error of estimate=1.641);

stance GL_3 (young men)= -0.775 + 0.120×Gl'LsPog' 27×MdLD45 + 0.910×MdLD11 + 0.065×L-Mand - ×MdK16 + 1.002×VoK15 + 1.726×MdK14 (R^2=0.753, =14.40, p<0.001, Std.Error of estimate=1.141);

stance PonPr (young men)= 5.701 + 1.366×MdK12 + 1.573×MdK15 - 0.478×MdLR12 + 2.217×MdK45 + 2.042×MdK41 - 0.319×MdLD14 (R^2=0.801, $F_{(6.34)}$=22.80, p<0.001, Std.Error of estimate=1.002);

distance PonM (young men)= 35.38 + 2.544×VoK15 + 0.751×MdLD44 - 0.494×MdLD14 - 0.124×G - 0.157×Sn-Pn - 1.808×VoK42 + 1.453×VoK43 (R^2=0.758, $F_{(7.33)}$=14.75, p<0.001, Std.Error of estimate=1.392);

distance VestBM (young men)= 48.12 + 2.526×VoK15 + 1.282×MdLD44 - 0.569×MdLD42 - 0.625×MdLD45 - 0.122×G - 0.074×Max (R^2=0.786, $F_{(6.34)}$=20.87, p<0.001, Std.Error of estimate=1.326);

distance 13_23Bugr (young men)= 7.992 + 2.502×MdK12 + 1.849×MdK13 - 0.487×VoLR12 - 0.913×VoK14 + 1.396×MdK41 + 1.171×MdC41 (R^2=0.764, $F_{(6.34)}$=18.34, p<0.001, Std.Error of estimate=1.058);

distance 13_23Apx (young men)= 38.82 + 0.205×Max1-SpP + 0.322×Li-SnPog' - 1.357×VoK16 + 2.037×VoK45 - 2.229×VoK13 + 1.742×MdK12 + 0.450×MdLD14 - 2.237×MdK13 - 0.072×L-Mand - 0.124×B (R^2=0.771, $F_{(10.29)}$=9.14, p<0.001, Std.Error of estimate=1.270);

distance napx_6 (young men)= 37.58 + 3.061×MdC42 - 2.737×VoK16 + 4.664×MdK12 - 0.732×VoLR13 + 0.762×MdLD45 - 0.800×VoLR11 - 0.097×Max (R^2=0.715, $F_{(7.33)}$=11.84, p<0.001, Std.Error of estimate=1.876);

distance dapx_6 (young men)= -23.49 + 2.973×VoK15 + 3.030×MdK46 - 5.057×MdC13 + 1.121×VoLK13 + 2.296×MdK12 + 3.452×MdK15 + 2.377×VoC13 - 1.996×MdK16 (R^2=0.764, $F_{(8.32)}$=12.95, p<0.001, Std.Error of estimate=2.374);

distance mapex_6 (young men)= -44.74 + 3.792×MdK45 + 4.363×MdK15 + 3.178×MdK12 + 0.309×H + 1.630×MdC41 - 0.567×MdLR42 - 1.567×VoK15 + 1.476×VoK12 (R^2=0.872, $F_{(8.32)}$=27.14, p<0.001, Std.Error of estimate=1.328);

distance 33_43Bugr (young men)= -0.244 + 1.476×MdK12 + 2.401×MdK42 - 0.420×MdLR11 + 0.376×MdLD43 - 0.243×VoLR13 + 0.202×MdLR42 (R^2=0.704, $F_{(6.34)}$=13.45, p<0.001, Std.Error of estimate=0.871);

distance 33_43Apx (young men)= 22.05 + 0.884×MdLD43 - 0.124×Max + 4.785×VoK43 - 2.772×VoC43 - 1.923×VoK42 - 0.468×MdLD45 - 1.865×MdK15 (R^2=0.751, $F_{(7.33)}$=14.21, p<0.001, Std.Error of estimate=1.273);

distance mapx_46 (young men)= 13.14 + 1.487×MdLK12 + 2.458×MdK45 + 2.978×VoK16 - 0.664×MdLD45 - 2.050×VoK46 - 0.083×R.asc. + 2.985×MdK42 (R^2=0.782, $F_{(7.32)}$=16.43, p<0.001, Std.Error of estimate=1.401);

distance dapx_46 (young men)= 23.21 + 0.143×Mand1-MP - 0.169×Max + 1.552×VoK16 + 1.910×MdC12 - 2.452×VoK12 + 1.978×VoK15 (R^2=0.747, $F_{(6.33)}$=16.26, p<0.001, Std.Error of estimate=1.551);

where, here and in the following equations, R^2 – coefficient of determination; $F_{()}$=! – critical $_{()}$ and obtained (!) Fisher's test value; p – confidence level; Std.Error of estimate – standard error of estimate.

In Ukrainian young women with physiological occlusion the following significant regression models (with a coefficient of determination R^2>0.60) of the linear dimensions required for constructing the correct dental arch form depending on the characteristics of cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions were constructed:

distance DL_F (young women)= 1.379 + 1.202×MdK11 + 0.141×Li-SnPog' + 0.879×VoK12 + 0.101×Sn-Pn - 0.043×Mand1-MP + 0.186×VoLR11 (R^2=0.680, $F_{(6.61)}$=21.59, p<0.001, Std.Error of estimate=0.817);

distance DL_S (young women)= 7.206 + 1.201×MdK11 + 0.211×Li-SnPog' + 0.706×VoK12 + 0.351×MdLK11 - 0.068×Mand1-MP + 0.627×MdK16 + 0.239×MdLD41 (R^2=0.800, $F_{(7.60)}$=34.29, p<0.001, Std.Error of estimate=0.776);

distance GL_2 (young women)= 4.175 + 0.368×MdLK42 + 0.193×Max1-SpP + 1.600×MdK46 - 1.610×VoLK43 - 0.259×I + 1.161×VoLK41 + 1.128×VoK46 - 1.464×MdK16 + 1.133×MdK45 (R^2=0.635, $F_{(9.58)}$=11.20, p<0.001, Std.Error of estimate=1.557);

distance 13_23Bugr (young women)= -12.68 + 1.122×MdK11 + 0.132×Gl'LsPog' - 0.039×MdC43 + 0.882×MdK43 + 0.352×VoLK11 + 0.290×MdLK42 + 0.820×VoC12 (R^2=0.632, $F_{(7.60)}$=14.71, p<0.001, Std.Error of estimate=1.090);

distance mapx_46 (young women)= 25.26 + 1.640×MdK16 - 0.066×MdC43 - 0.190×T + 1.096×MdLK13 - 0.368×Li-SnPog' + 1.938×MdK15 - 1.215×VoK44 (R^2=0.611, $F_{(7.54)}$=12.13, p<0.001, Std.Error of estimate=1.820);

distance dapx_46 (young women)= 17.87 - 0.197×T + 0.954×MdLD45 - 0.455×VoLK11 + 2.311×MdC12 + 0.152×Gl'LsPog' - 0.444×MdLR41 - 0.841×VoK44 (R^2=0.698, $F_{(7.54)}$=17.81, p<0.001, Std.Error of estimate=1.886).

Since, in *young women* in the constructed reliable distance models, *DL_C*, *GL_1*, *GL_3*, *PonPr*, *PonM*, *VestBM*, *13_23Apx*, *napx_6*, *dapx_6*, *mapex_6*, *33_43Bugr* and *33_43Apx* the coefficient of determination of the regression equations is from 0.340 to 0.594, these models do not have important practical significance for dentists.

Discussion

Thus, in Ukrainian young men with physiological occlusion all 18 possible significant (p<0.001 in all cases) models of the linear parameters of the dental arches depending on the characteristics of cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions were constructed with a coefficient of determination greater than 0.6 (R^2= from 0.680 to 0.893).

As a result of the analysis of the frequency with which cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions entered the regression equations in young men the following percentage of inclusion of these parameters in the models was established: crown width in the vestibulo-oral (22.66 %) and mesio-distal plane (21.88 %), cephalometric parameters according to the Schwarz method (17.97 %), tooth length (13.28 %), root portion length in the mesio-distal (6.25 %) and vestibulo-oral plane (4.69 %), cervical portion width in the mesio-distal (4.69 %) and vestibulo-oral plane (3.13 %), and crown portion length in the mesio-distal (3.13 %) and vestibulo-oral plane (2.34 %).

As a result of the analysis of the frequency with which the corresponding teeth entered the regression equations in young men the following percentage of inclusion of these parameters in the models was established: 22.86 % maxillary incisors (of which 15.24 % lateral and 7.62 % central), 19.05 % mandibular incisors (of which 11.43 % lateral and 7.62 % central), 18.09 % maxillary premolars (of which 12.38 % second and 5.71 % first), 13.33 % mandibular premolars (of which 11.43 % second and 1.90 % first), 12.38 % maxillary canines, 5.71 % maxillary first molars, 4.76 % mandibular canines and 3.81 % mandibular first molars.

In Ukrainian young women with physiological occlusion, of 18 possible models only 6 significant (p<0.001 in all cases) models of the linear parameters of the dental arches depending on the characteristics of cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions were constructed with a coefficient of determination greater than 0.6 (R^2= from 0.611 to 0.800).

As a result of the analysis of the frequency with which cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions entered the regression equations in young women the following percentage of inclusion of these parameters in the models was established: cephalometric parameters according to the Schwarz method (27.91 %), crown portion width in the mesio-distal (23.26 %) and vestibulo-oral plane (11.63 %), crown portion length in the mesio-distal and vestibulo-oral plane (9.30 % each), cervical portion width in the mesio-distal (6.98 %) and vestibulo-oral plane (2.33 %), tooth length (4.65 %), and root portion length in the mesio-distal and vestibulo-oral plane (2.33 % each).

As a result of the analysis of the frequency with which the corresponding teeth entered the regression equations in young women the following percentage of inclusion of these parameters in the models was established: 35.48 % maxillary incisors (of which 22.58 % central and 12.90 % lateral), 16.13 % mandibular incisors (of which 9.68 % central and 6.45 % lateral), 12.90 % mandibular canines, 12.90 % mandibular premolars (of which 6.45 % first and 6.45 % second), 9.68 % maxillary first molars, 6.45 % mandibular first molars, 3.23 % maxillary canines and 3.23 % maxillary second premolars.

Our findings support the feasibility of formulating sex-specific regression models of the linear variables of the dental arches that include both cephalometric indicators according to Schwarz and computed-tomographic odontometric features. In Ukrainian young men with physiological occlusion, it was possible to construct all 18 significant models, with R^2 values ranging from 0.680 to 0.893 (p<0.001), whereas in young women only 6 models with R^2 values from 0.611 to 0.800 (p<0.001) were obtained [16, 20, 21, 22].

Among the correlations between CT-derived measurements of the dental arches and jaws, the most numerous are those involving mesiodistal crown dimensions (53.5 %) and buccolingual crown dimensions (50.7 %), as well as the width of the dentinoenamel junction in the buccolingual direction (54.2 %) [14]. This is consistent with the fact that in our models for young men the frequency of inclusion of crown width in the vestibulo-oral and mesiodistal planes was 22.66 % and 21.88 %, respectively, while tooth length was included in 13.28 % of cases, that is, these parameters constitute the "core" of predictability for the linear dimensions of the dental arches. Similarly, in young women the largest proportion of predictors was represented by cephalometric characteristics (27.91 %) and by crown width in the mesiodistal (23.26 %) and vestibulo-oral planes (11.63 %), which mirrors the structure of relationships described in the studies by Marchenko A. V. on different craniofacial types [14, 15].

Our findings also agree with the conclusions of the review by Ryabov T. V., based on multiple studies of tooth size versus cranial parameters, which suggests that most correlations between tooth dimensions and cranial factors are moderate or greater strength (often r>0.4-0.5, p<0.05) and should be considered separately for different sexes, age-related stages of development and facial patterns [25].

In the works of Brotskyi N. O. and co-authors regression models of the linear dimensions required for the formation of correct dental arch shape were constructed on the basis of teleradiography according to Ricketts and computed-tomographic tooth dimensions in boys and girls with wide and very wide facial types; high coefficients of determination were obtained, and mesiodistal and vestibulo-oral crown diameters were identified as particularly important predictors [5, 6].

In research conducted by Prokopenko O. S. in young men and women with various facial profiles, regression models were constructed for teleradiographic indicators of tooth position and soft tissue facial profile according to Schwarz; these models showed high sensitivity to sex and profile type [20]. A similar principle was applied in the study by Marchenko A. V. et al., where mathematical modeling of cephalometric values according to Schwarz was based on basic craniometric indices, and in the study by Nesterenko ... et al., where COGS parameters were modeled in young women with a broad facial type [16, 18]. The approach presented by Dmitriev M. O. for modeling COGS parameters, with subdivision of indices into three groups, reflects the fact that not all indices contribute equally to the formation of dental arch form and occlusal relationships, emphasizing that only part of the indicators makes a substantial contribution to the variability of arch morphology and occlusion [10, 18].

From a methodological point of view, the justification for the use of computed tomography for combined cephalo-odontometric assessment is particularly important. In the study by Devanna R. a three-dimensional CBCT-based cephalometric analysis was developed, which made it possible to determine 3D cephalometric norms with good reproducibility of measurements compared with conventional two-dimensional methods [9]. The study by Lin Y. et al. in children with operated unilateral cleft lip and palate showed that CBCT-reconstructed lateral cephalograms allow detection of differences in craniofacial structures between clinical groups and are not less informative than the traditional method [11]. In the systematic review by Raj G. and colleagues the diagnostic accuracy and reproducibility of CBCT-synthesized lateral cephalograms were found to be equivalent to those of conventional lateral cephalograms in 20 included studies, and in four studies even higher accuracy of CSLC was reported [23]. Taken together, these data support the use of CBCT as a high-precision source of odontometric and cephalometric measurements and verify our methodological approach, which further develops teleradiography according to Schwarz by adding detailed three-dimensional characterization of tooth dimensions.

Given the current discussion regarding the predictability of classical indices (particularly Pont) with respect to dental arch width in various populations, our findings gain special interest. In the Malay sample studied by Alam M. K. and co-authors using CBCT it was shown that predictions based on Pont's index often failed to correspond to the actual interpremolar and intermolar widths, which raises questions about the universality of classical formulas [2]. More recently, much more rigorous conclusions were reached by Mahmood T. M. A. et al., who demonstrated in a Kurdish sample that actual arch width differed significantly from the calculated values and that only weak positive correlations between them were observed; the authors explicitly call for the development of alternative formulas based on scan-derived data [13]. The models we constructed, with high R^2 values based on real computed-tomographic tooth dimensions and cephalometric indicators, in fact implement this approach for Ukrainian young men and women with physiological occlusion, offering a personalized rather than a "universal" forecast of dental arch form [2, 5, 6, 13].

A. Potapchuk and co-authors studied dental arch forms and their correlations with morphotopogeometric facial parameters and reported that the shape and dimensions of the dental arches exert a considerable influence on the morphotopogeometric characteristics of the face and therefore can be regarded as one of the significant factors in achieving harmonious aesthetic proportions [19].

Conclusions

1. In Ukrainian young men and women with physiological occlusion without taking facial type into account significant regression models of the linear parameters of the dental arches depending on the characteristics of cephalometric parameters according to the Schwarz method and computed-tomographic tooth dimensions with a coefficient of determination greater than 0.6 were constructed (in young men all 18 possible models, R^2= from 0.680 to 0.893; in young women only 6, R^2= from 0.611 to 0.800).

2. In the analysis of the frequency with which cephalometric

parameters according to the Schwarz method and computed-tomographic tooth dimensions entered the models in young men the variables most frequently included in the models are crown width in the vestibulo-oral (22.66 %) and mesio-distal plane (21.88 %), cephalometric parameters (17.97 %) and tooth length (13.28 %); and in young women cephalometric parameters (27.91 %) and crown width in the mesio-distal (23.26 %) and vestibulo-oral plane (11.63 %).

3. In the analysis of the frequency with which the corresponding teeth entered the models in young men the teeth most frequently included in the models are maxillary incisors (22.86 %), mandibular incisors (19.05 %), maxillary premolars (18.09 %), mandibular premolars (13.33 %) and maxillary canines (12.38 %); and in young women maxillary incisors (35.48 %), mandibular incisors (16.13 %), mandibular canines and mandibular premolars (12.90 % each).

References

[1] Alajlan, S. S., Alsaleh, M. K., Alshammari, A. F., Alharbi, S. M., Alshammari, A. K., & Alshammari, R. R. (2019). The prevalence of malocclusion and orthodontic treatment need of school children in Northern Saudi Arabia. *Journal of orthodontic science*, *8*(1), 10. doi: 10.4103/jos.JOS_104_18

[2] Alam, M. K., Shahid, F., Purmal, K., & Khamis, M. F. (2015). Cone-beam computed tomography evaluation of Pont's index predictability for Malay population in orthodontics. *Journal of natural science, biology, and medicine*, *6*(Suppl 1), S113-S117. doi: 10.4103/0976-9668.166106

[3] Alhammadi, M. S., Halboub, E., Fayed, M. S., Labib, A., & El-Saaidi, C. (2018). Global distribution of malocclusion traits: A systematic review. *Dental press journal of orthodontics*, *23*(06), 40-e1. doi: 10.1590/2177-6709.23.6.40.e1-10.onl

[4] Atasever İşler, A. A., Hezenci, Y., & Bulut, M. (2025). Prevalence of orthodontic malocclusion in children aged 10–12: an epidemiological study. *BMC Oral Health*, *25*(1), 249. doi: 10.1186/s12903-025-05650-x

[5] Brotskyi, N. O., Dmitriev, M. O., Karliychuk, M. A., Ocheretna, N. P., & Shevchuk, Y. G. (2025). Regression models of the dimensions of the dental arch shape in girls with a physiological bite and a very wide facial type depending on the features of telerontgenometric indicators by the Ricketts method and computed tomographic dimensions of the teeth. *Світ медицини та біології=World of Medicine and Biology*, *2*(92), 35-39. doi: 10.26724/2079-8334-2025-2-92-35-39

[6] Brotskyi, N. O., Dmitriev, M. O., Arshynnikov, R. S., Drachuk, N. V., Popova, O. I., Moskalenko, V. B., & Ruban, M. M. (2024). Models of linear dimensions necessary for constructing the correct shape of the dental arch in boys and girls with a wide face type depending on the characteristics of teleradiometric indicators. *Вісник Вінницького національного медичного університету=Reports of Vinnytsia National Medical University*, *28*(4), 613-619. doi: 10.31393/reports-vnmedical-2024-28(4)-06

[7] de Freitas, C. V., Souza, J. G. S., Mendes, D. C., Pordeus, I. A., Jones, K. M., & de Barros Lima, A. M. E. (2015). Need for orthodontic treatment among Brazilian adolescents: evaluation based on public health. *Revista Paulista de Pediatria (English Edition)*, *33*(2), 204-210. doi: 10.1016/S2359-3482(15)30052-X

[8] De Ridder, L., Aleksieva, A., Willems, G., Declerck, D., & Cadenas de Llano-Pérula, M. (2022). Prevalence of orthodontic malocclusions in healthy children and adolescents: a systematic review. *International journal of environmental research and public health*, *19*(12), 7446. doi: 10.3390/ijerph19127446

[9] Devanna, R. (2015). Two-dimensional to three-dimensional: A new three-dimensional cone-beam computed tomography cephalometric analysis. *Journal of Orthodontic Research*, *3*(1), 30. doi: 10.4103/2321-3825.146356

[10] Dmitriev, M. O., Gunas, I. V., Dzevulska, I. V., & Zhulkevych, I. V. (2018). Determination of individual cephalometric characteristics of the occlusal plane in Ukrainian young men and young women with orthognatic bite. *Biomedical and Biosocial Anthropology*, (33), 5-11. doi: 10.31393/bba33-2018-1

[11] Lin, Y., Fu, Z., Ma, L., & Li, W. (2016). Cone-beam computed tomography–synthesized cephalometric study of operated unilateral cleft lip and palate and noncleft children with Class III skeletal relationship. *American Journal of Orthodontics and Dentofacial Orthopedics*, *150*(5), 802-810. doi: 10.1016/j.ajodo.2016.03.031

[12] Luo, J., Liu, T., Wang, Y., & Li, X. (2024). The association between dental and dentoalveolar arch forms of children with normal occlusion and malocclusion: a cross-sectional study. *BMC Oral Health*, *24*(1), 731. doi: 10.1186/s12903-024-04515-z

[13] Mahmood, T. M. A., Noori, A. J., Aziz, Z. H., Rauf, A. M., & Kareem, F. A. (2023). Scan aided Dental Arch Width Prediction via internationally recognized formulas and indices in a sample of kurdish Population/Iraq. *Diagnostics*, *13*(11), 1900. doi: 10.3390/diagnostics13111900

[14] Marchenko, A. V. (2018). Connections of transversal volumes of the upper and lower jaw and sagittal characteristics of the dental arch with odontometric and cephalometric indicators of youth brachycephals with orthognathic bite. *Світ медицини та біології=World of Medicine and Biology*, *1*(63), 47-52. doi: 10.26724/2079-8334-2018-1-63-47-52

[15] Marchenko, A. V. (2018). Relationships of linear dimensions necessary for constructing the correct form of the dental arch with odontometric and cephalometric indicators in mesocephalic girls with orthognathic bite. *Klinichna Stomatolohiia (Clinical Dentistry)*, *1*, 50-59. doi: 10.11603/2311-9624.2018.1.8582

[16] Marchenko, A. V., Prokopenko, O. S., Dzevulska, I. V., Zakalata, T. R., & Gunas, I. V. (2021). Mathematical modeling of teleroentgenographic parameters according to the method of Schwarz am depending on the basic cephalometric parameters in ukrainian young men and young women with different face types. *Wiadomosci lekarskie (Warsaw, Poland: 1960)*, *74*(6), 1488-1492. PMID: 34159943

[17] Marchenko, A. V., Gunas, I. V., Petrushanko, T. O., Serebrennikova, O. A., & Trofimenko, Yu. Yu. (2017). Computer-tomographic characteristics of root length incisors and canines of the upper and lower jaws in boys and girls with different craniotypes and physiological bite. *Wiadomosci Lekarskie (Warsaw, Poland: 1960)*, *70*(3 pt 1), 499-502. PMID: 28711896

[18] Nesterenko, Ye. A., Shevchuk, Yu. G., Shinkaruk-Dykovytska, M. M., Lysenko, S. A., & Chugu, T. V. (2023). Simulation of individual teleradiographic indicators using the "Cephelometrics for orthognathic surgery" method in

Ukrainian young women with a very broad face type. *Світ медицини та біології=World of Medicine and Biology*, *2*(84), 119-123. doi: 10.26724/2079-8334-2023-2-84-119-123

[19] Potapchuk, A., Almashi, V., Horzov, A., & Kostenko, S. (2024). Comparative analysis of the influence of the shapes and dimensions of dental arches on the morphotopogeometric characteristics of the facial area. *Polski Merkuriusz Lekarski: Organ Polskiego Towarzystwa Lekarskiego*, *52*(3), 356-362. doi: 10.36740/Merkur202403113

[20] Prokopenko, O. S. (2021). Regression models of teleradiographic indicators of the position of teeth and the profile of face soft tissues in Ukrainian young men and young women with different face profiles according to Schwarz AM. *Вісник Вінницького національного медичного університету=Reports of Vinnytsia National Medical University*, *25*(2), 208-214. doi: 10.31393/reports-vnmedical-2021-25(2)-05

[21] Prokopenko, O. S., Beliaiev, E. V., Gulmen, M. K., Popova, O. I., & Cherkasova L. A. (2020). Features of t teleroentgenographic parameters of the upper and lower jaws in Ukrainian young men and young women with orthognathic occlusion and with different types and profiles of the face according to Schwarz A. M.. *Biomedical and Biosocial Anthropology*, (39), 62-69. doi: 10.31393/bba39-2020-10

[22] Prokopenko, O. S.; Polishchuk, S. S., Prokopenko, S. V., Gunko, I. P., & Haiduk, O. A. (2023). Correlations of teleroentgenographic parameters of the jaws with basic craniometric parameters in juvenile men and juvenile women with orthognathic bite and different facial types according to Schwarz A. M.. *Світ медицини та біології=World of Medicine and Biology*, *2*(84), 124-128. doi: 10.26724/2079-8334-2023-2-84-124-128

[23] Raj, G., Raj, M., & Saigo, L. (2024). Accuracy of conventional versus cone-beam CT-synthesised lateral cephalograms for cephalometric analysis: A systematic review. *Journal of Orthodontics*, *51*(2), 160-176. doi: 10.1177/14653125231178038

[24] Rullo, R., Festa, V. M., Rullo, R., Addabbo, F., Chiodini, P., Vitale, M., & Perillo, L. (2015). Prevalence of dental anomalies in children with cleft lip and unilateral and bilateral cleft lip and palate. *Eur J Paediatr Dent*, *16*(3), 229-232. PMID: 26418927

[25] Ryabov, T. V. (2022). Relationship of odontometric and cephalometric indicators: Review of literary sources. *Вісник Вінницького національного медичного університету=Reports of Vinnytsia National Medical University*, *26*(4), 687-691. doi: 10.31393/reports-vnmedical-2022-26(4)-29

[26] Schwarz, A. M. (1960). *Röntgenostatics; Practical Evaluation of the Tele-X-ray-photo (study-head-plate) (Vol. 1)*. Leo L. Bruder.

[27] Schwarz, A. M. (1961). Roentgenostatics: a practical evaluation of the x-ray headplate. *American Journal of Orthodontics*, *47*(8), 561-585. doi: 10.1016/0002-9416(61)90001-X

[28] Simões, R. C., Goettems, M. L., Schuch, H. S., Torriani, D. D., & Demarco, F. F. (2017). Impact of malocclusion on oral health-related quality of life of 8-12 years old schoolchildren in Southern Brazil. *Brazilian Dental Journal*, *28*, 105-112. doi: 10.1590/0103-6440201701278

[29] Yin, J., Zhang, H., Zeng, X., Yu, J., Wang, H., Jiang, Y., ... & Zhang, Y. (2023). Prevalence and influencing factors of malocclusion in adolescents in Shanghai, China. *BMC Oral Health*, *23*(1), 590. doi: 10.1186/s12903-023-03187-5

[30] Zhou, Z., Liu, F., Shen, S., Shang, L., Shang, L., & Wang, X. (2016). Prevalence of and factors affecting malocclusion in primary dentition among children in Xi'an, China. *BMC Oral Health*, *16*(1), 91. doi: 10.1186/s12903-016-0285-x

РЕГРЕСІЙНІ МОДЕЛІ ПАРАМЕТРІВ НЕОБХІДНИХ ДЛЯ ПОБУДОВИ КОРЕКТНОЇ ФОРМИ ЗУБНОЇ ДУГИ В ЗАЛЕЖНОСТІ ВІД ОСОБЛИВОСТЕЙ ТЕЛЕРЕНТГЕНОМЕТРИЧНИХ ПОКАЗНИКІВ ЗА МЕТОДОМ SCHWARZ І КОМП'ЮТЕРНО-ТОМОГРАФІЧНИХ РОЗМІРІВ ЗУБІВ В УКРАЇНСЬКИХ ЮНАКІВ І ДІВЧАТ ІЗ ФІЗІОЛОГІЧНИМ ПРИКУСОМ

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Аномалії прикусу та розбіжності у формі зубних дуг залишаються дуже поширеними серед дітей та підлітків у всьому світі, суттєво впливаючи на здоров'я порожнини рота, естетику обличчя та якість життя. Тому точне, специфічне для популяції прогнозування індивідуальних параметрів зубних дуг на основі цефалометричних та одонтометричних характеристик є важливим для персоналізованого планування ортодонтичного та ортогнатичного лікування у молодих пацієнтів з фізіологічним прикусом. Мета дослідження – побудувати та провести аналіз регресійних моделей розмірів необхідних для побудови коректної форми зубної дуги в українських юнаків і дівчат із фізіологічним прикусом в залежності від телерентгенометричних показників за методом Schwarz і комп'ютерно-томографічних розмірів зубів. В застосунку OnyxCeph³™, версії 3DPro (компанія Image Instruments GmbH, Німеччина) на отриманих стандартним шляхом телерентгенограмах і створених в програмному забезпеченні 3D Slicer v5.4.0 телерентгенограмах з маркованими на 3D об'єктах точками у 41 українського юнака і 68 дівчат із фізіологічним прикусом проведено вимірювання телерентгенометричних показників за методом Schwarz. Також в юнаків і дівчат в програмних застосунках i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor та Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY на комп'ютерних томограмах проведено вимірювання розмірів зубів верхньої й нижньої щелеп та лінійних параметрів зубних дуг. За допомогою ліцензійного пакету «Statistica 6.0» побудовані регресійні моделі параметрів коректної форми зубної дуги в залежності від особливостей телерентгенометричних показників і комп'ютерно-томографічних розмірів зубів. Встановлено, що в юнаків побудовані усі 18 можливих достовірних моделей із коефіцієнтом детермінації більшим 0,6 (R^2= від 0,680 до 0,893, p<0,001); а у дівчат – лише 6 достовірних моделей із коефіцієнтом детермінації більшим 0,6 (R^2= від 0,611 до 0,800, p<0,001). При аналізі частоти входження до регресійних рівнянь комп'ютерно-томографічних розмірів зубів і телерентгенометричних показників встановлено: в юнаків найбільш часто до моделей входять ширина коронкової частини зуба у вестибуло-оральній і мезіо-дистальній площині, телерентгенометричні показники та довжина зуба; а у дівчат – телерентгенометричні показники та ширина коронкової частини зуба у мезіо-дистальній і вестибуло-оральній площині. При аналізі частоти входження до регресійних рівнянь відповідних зубів встановлено, що в юнаків до моделей найбільш часто входять верхні різці, нижні різці, верхні малі кутні зуби, нижні малі кутні зуби та верхні ікла; а у дівчат

– верхні різці, нижні різці, нижні ікла та нижні малі кутні зуби.

Ключові слова: *стоматологія, телерентгенометрія за методом Schwarz, комп'ютерно-томографічні розміри зубів і зубних дуг, регресійний аналіз, українськи юнаки та дівчата з фізіологічним прикусом.*

Author's contribution

Spodaruk A. L. – research, methodology and writing of the original draft.
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