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Correlation of Vertical Dimensions of Soft Tissue Facial Profiles

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الخلاصة

الأهداف: تهدف الدراسة إلى ايجاد العلاقات بين القياسات الخطية للارتفاعات العمودية الوجهية لمختلف انواع الاوجه بالنسبة للطلبة العراقيين البالغين. **المواد وطرائق العمل: تم**إختيار 75 طالبا(48ذكر، 27 انثى) ذوي اوجه متناسقة من كلية طب الاسنان/جامعة الموصل.لكل شخص تم تحديد سبع قياسات خطية مباشرة على وجه الشخص، تحت ظروف ثابتة(مستوى فرانكفورت موازي للارض) و باستخدام الة قياس(فرنيا) صينية الصنع: (ارتفاع الوجه الامامي،الثلث الوجهي العلوي،الثلث الجبهي،الثلث الوجهي الوسطي،الثلث الانفي، الثلث الوجهي السفلي،الثلث الحنكي،الارتفاع العمودي بحالة الراحة، الارتفاع العمودي بحالة الاطباق وزاوية تحدب النسيج الرخوي للوجه باستثناءالانف من الجانب). **النتائج:** أظهرت النتائج أن الوجوه ذات النوع المقعر من الجانب اظهرت قيما كبيرة معنويا للثلث الوجهي السفلي، الثلث الوجهي الوسطي والفسحة الفراغية الحرة،بينما الارتفاع العمودي بحالة الاطباق اظهر قيمة اصغر معنويا،مشيرا الى ان الثلث الوجهي الوسطي والثلث الوجهي السفلي مسؤولان عن القيمة الكبيرة للارتفاع الوجهي الامامي بالنسبة لهؤلاء الاشخاص، بالمقارنة مع انواع الاوجه الاخرى. توزعت المتغيرات الاخرى بين المستويات الاحصائية اللامعنوية العلوية والسفلية ضمن الاوجه المختلفة. وقد وجدت علاقات عديدة بين المتغيرات المدروسة للعينة كاملة، ولكل من الذكور والاناث و لمختلف انواع الاوجه أهم هذه العلاقات كانت علاقة موجبة وعالية المعنوية بين الارتفاع العمودي بحالة الراحة والارتفاع العمودي بحالة الاطباق، مع ارتفاع الوجه الامامي والثلث الوجهي السفلي للوجوه المستقيمة والمحدبة. **الاستنتاجات:**لوحظت علاقات متنوعة بين مختلف القياسات الخطية للارتفاعات العمودية الوجهية والنسب البعدية لمختلف انواع الاوجه بالنسبة للطلبة العراقيين البالغين.

ABSTRACT

Aims: To establish the interrelationships of linear measurements of the vertical facial heights among different facial profiles in young Iraqi adult students**. Materials and Methods:** 75 students (48 males, 27females) of pleasing face, balanced facial profile were selected from the College of Dentistry, University of Mosul**.** For each subject seven vertical linear measurements{ Anterior facial height (n–gn), upper facial third, frontal third (tr–n), middle facial third, nasal third (n–sn), lower facial third, gnathic third, (sn–gn), rest vertical dimension (RVD)(pn–pog), occlusal vertical dimension (OVD) (pn–pog) and angle of soft tissue profile facial convexity excluding the nose (n–sn–pog)} were measured directly on the subject's face under standarized conditions keeping Frankfort plane parallel to floor, using electronic digital vernier caliper (China)**. Results:** sn–me, n–sn and free way space are significantly larger, while pn–pog (OVD) is significantly smaller in concave facial profiles ($p \leq 0.05$) indicating that the lower and middle facial thirds are responsible for the greater anterior facial height in these subjects compared with other facial profiles' subjects. The remaining variables distributed on statistical levels of difference between the upper and lower levels with non–significant difference ($p>0.05$) within facial profiles. Various correlations were noticed among all the studied variables for total sample, males and females and in different facial profiles. Of most important, is the positive significantly high correlation of pn–pog (OVD) and pn–pog (RVD) with n–me, sn–me for convex and straight profiles. **Conclusions**: From this study ,spatial relationships among various vertical facial dimensions and the dimensional proportions of different facial profiles in young Iraqi adult students were noticed.

Key Words: Esthetics, Facial profile, Occlusal vertical dimension, Rest vertical dimension.

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INTRODUCTION

Esthetics is the primary reason why patients seek orthodontic /prosthodontic treatment and the resulting soft tissue profile is their measure of therapeutic success[1]. Attention to physical appearance, particularly of the face, has become a very important issue in modern society[2]. Although evi-

dence exists for a universal standard for proportions involved in facial attractiveness[3], there may be differences in perception of the soft tissue drape among ethnic groups[4].

The search for the profile with ideal proportions is one of the oldest aims of art. These ideal proportions provide the basic standard for assessment of the average profile–mean value, biometric mean, or average. The profile may be divided into three approximately equal parts: Frontal third (tr–n), nasal third (n–sn), gnathic third (sn–gn). The gnathic third may be up to a tenth greater rather than smaller[5].

Similar proportion (n–gn) with mid–face (n–sn) may be seen with respect to anterior face height, occupying 45%, the lower face (sn–gn) 55% of the total height[5].

Number of methods have been used to evaluate the facial esthetic (two dimensional) including anthropometry[6–9], photogrammetry[9], cephalometry[10–12], and computer imaging[13,14]. Current technology provides several noninvasive image analysis systems for indirect computerized facial anthropometry including stereophotogrammetry, laser scanning, range cameras, optoelectronic instruments, and electromagnetic digitizers[15–20]. In addition, ultrasonography allows facial anthropometry to be performed even during intrauterine life[21,22].

These instruments provide the three–dimensional coordinates of selected landmarks, and euclidean geometric calculations can be used to obtain three–dimensional linear distances of selected facial structures, as well as facial areas and volumes [15–23].

Both of vertical dimensions, the occlusal (OVD) and the rest vertical (RVD) dimensions are subjected to change resulting from loss of teeth[24], orthodontic and/or orthopedic treatment[25]. The physiologic rest position has been considered by many authors to remain constant throughout life regardless the presence or absence of teeth[26].

Although there appears to be considerable agreement across cultures about what facial anatomical relationships are attractive, there are variations in the soft–tissue drape related to possible cultural influences on the perception of attractiveness[27].

An important point to be considered is that this study concentrated only on pleasing faces individuals, malocclusions were omitted from study group. According to Kim *et al*.,[28] the range of a normal occlusion includes quite diverse anteroposterior and vertical skeletal relationships.

The purpose of the current study was to establish the linear measurements of the vertical facial heights among different facial profiles in young Iraqi adult students, to report the presence of any sexual dimorphism in these parameters and to demonstrate the interrelationships among these parameters.

MATERIALS AND METHODS

The sample consists of 75 students (48 males, 27 females) satisfying the criteria of pleasing face, balanced facial profile, competent lips, and normal overjet and overbite relationship, were selected independently by two investigators from the College of Dentistry/University of Mosul. Subjects who satisfied these criteria even when they had malocclusions were not excluded from the study[29]. The subjects were randomly selected healthy subjects, of estimated mean age 21 years and five months and with the permanent dentition completely erupted (except for wisdom teeth). The subjects had no congenital anomalies and no significant facial, dental asymmetries, none of these subjects had undergone, orthopedic, orthodontic treatment or, orthognathic surgery and no previous history to facial trauma. Each subject was seated on a dental chair, asked about name, medical and dental history.

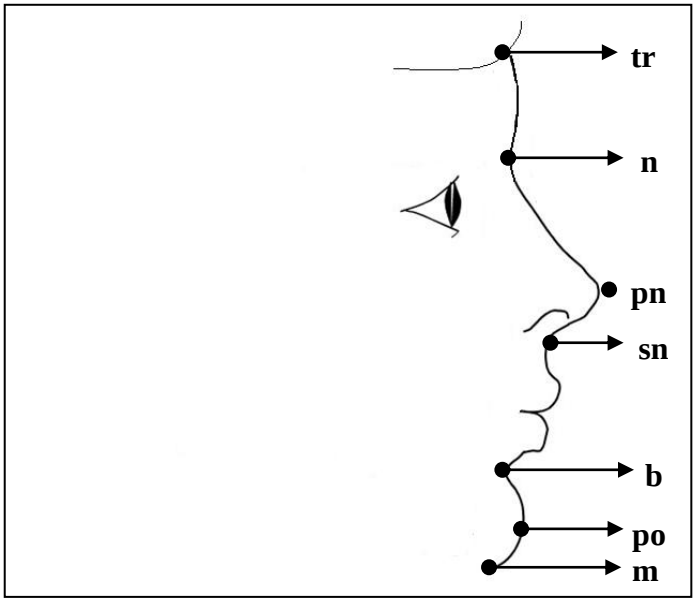
Extra and intra oral clinical assessment had been made, A pin–head sized marks were marked by an indelible pencil on the skin before measurement using water soluble marker.

Seven vertical linear measurements were measured directly on the subject's face and taken under standardized conditions keeping Frankfort plane parallel to floor. During registration of the rest vertical dimension (RVD), the subject's head must be erect, teeth separated and the lips gently touch with masticatory muscles completely

relaxed[30]. The occlusal vertical dimension (OVD) was determined by asking subject to relax and occlude his teeth in centric occlusion with lips closed, and the distance between the two marks was measured. The electronic digital vernier caliper (Lezaco Art 2771, 0–150 mm, 0–6 inch accuracy, China) was used to measure the seven vertical linear measurements in millimeters.

To make landmark determination as consistent as possible, a given landmark was identified for each subject at one sitting. Each was then checked by another investigator. In order to minimize measurement error, all linear measurements were performed by two investigators working independently. Intra–investigator and inter–investigator measurement error was predetermined at 0.5 mm, and no significant difference were noticed between the two measurements at $p \leq 0.05$.

The following soft tissue landmarks were defined as showed in Figure (1): Trichion (tr): A point located at the hairline of the forehead[5,6,9], soft tissue nasion (n): The most posterior point on the tissue overlying the frontonasal suture[29,31], pronasale (pn): The most prominent or anterior point of the nose [29,31], subnasale (sn): The point at which the columella merges with the upper coetaneous lip[8,9,29,31], soft tissue b–point (b): The point of greatest concavity in the midline of the lower lip between lower milion border and soft tissue pogonion[8,9,29,31], soft tissue pogonion (pog): The most anterior point of the soft tissue chin[29,31], soft tissue menton (me): The most inferior point of the soft tissue chin[29,31].



Figure(1): Soft tissue landmarks.

While soft tissue measurements included the following:

1. Anterior facial height (n–gn): the distance between point (n) and point (gn)[5].
2. Upper facial third, frontal third (tr–n): the distance between point tr and point n[5].
3. Middle facial third, nasal third (n–sn): the distance between point n and point sn[5].
4. Lower facial third, gnathic third (sn–gn): the distance between point sn and point gn[5].
5. Rest vertical dimension (RVD)(pn–pog): the postural position of the mandible when an individual is resting comfortably in upright position and associated muscles are in state of minimal contractual activity[30,32].
6. Occlusal vertical dimension (OVD) (pn–pog): the distance measured between two points when occluding member are in contact[30,32].
7. Angle of soft tissue profile facial convexity excluding the nose (n–sn–pog)[31,33].

For statistical analysis descriptive statistics including the mean, standard deviation, were calculated. Student *t* test was used to show the statistical difference between males and females. ANOVA and Duncan's multiple analysis range tests are used to reveal the statistical difference among different facial profiles. Pearson correlation coefficient was carried out among all the variables for males, females and total sample and in different facial profiles separately. Correlation is considered significant at $p \leq 0.05$ level and highly significant at $p \leq 0.01$ level.

RESULTS

The descriptive statistics including mean and standard deviations of all variables for the total sample, both males and females are presented in Table (1) which shows significant differences between males and females for all the studied variables with the males having the greater values at $p \leq 0.05$.

Table (1): Descriptive statistics of all variables for the total sample, males and females.

Variable	Total=75		Males=48		Females=27		t–value	Sig.**
	mean	SD	mean	SD	Mean	SD		
Soft tissue facial convexity*	2.329	0.619	2.286	0.677	2.407	0.501	3.017–	S
n–me	120.060	8.564	123.962	7.275	112.978	5.750	7.692	S
Tr–n	62.698	8.239	64.757	7.647	58.962	8.085	1.951	S
n–sn	56.023	4.026	57.411	3.805	53.506	3.133	3.447	S
sn–me	66.709	6.965	68.953	6.834	62.637	5.199	6.190	S
pn–pog(OVD)	66.736	6.468	68.247	6.134	63.993	6.254	3.309	S
pn–pog(RVD)	68.974	6.427	70.659	6.233	65.914	5.689	4.050	S
Free way space	2.5470	5.4031	3.2850	5.132	2.3280	2.9099	2.075	S

*Facial convexity: 0=concave, 1=straight, 2=slightly convex, 3=convex; **S=significant at $p \leq 0.05$; OVD=occlusal vertical dimension, RVD=rest vertical dimension.

The one way analysis of variance (ANOVA) comparing different facial profiles revealing significant differences among the three facial profiles for n–sn and sn–me and free way space (at $p \leq 0.05$), Table (2).

The results. of Duncan's multiple analysis range test (Table 3) showed that sn–me, n–sn and free way space are significantly larger, while pn–pog (OVD) is significantly smaller in concave facial profiles ($p \leq 0.05$). The remaining variables distributed on statistical levels of difference between the upper and lower levels with non– significant difference ($p \leq 0.05$) within facial profiles.

Table (2): Analysis of Variance (ANOVA) comparing different facial profiles.

Variable		Sum of Squares	df	Mean Square	F	Sig.
Soft tissue facial convexity*	Between Groups	56.022	3	18.674	1374.969	.000
	Within Groups	.964	71	1.358		
	Total	56.987	74			
n–me	Between Groups	333.790	3	111.263	1.677	.180
	Within Groups	4710.423	71	66.344		
	Total	5044.213	74			
tr–n	Between Groups	33.388	3	11.129	.154	.927
	Within Groups	5127.871	71	72.224		
	Total	5161.259	74			
n–sn	Between Groups	226.412	3	75.471	5.255	.002
	Within Groups	1019.706	71	14.362		
	Total	1246.118	74			
sn–me	Between Groups	264.155	3	88.052	2.018	.119
	Within Groups	3097.446	71	43.626		
	Total	3361.601	74			
pn–pog(OVD)	Between Groups	181.085	3	60.362	1.617	.193
	Within Groups	2649.725	71	37.320		
	Total	2830.811	74			
pn–pog(RVD)	Between Groups	121.612	3	40.537	1.085	.361
	Within Groups	2651.744	71	37.349		
	Total	2773.356	74			
Free way space	Between Groups	54.724	3	18.241	4.921	.004
	Within Groups	263.198	71	3.707		
	Total	317.922	74			

*Facial convexity: 0=concave, 1=straight, 2=slightly convex, 3=convex;**Tabulated F=2.6802 at $p \leq 0.05$; OVD=occlusal vertical dimension; RVD=rest vertical dimension.

Table (3): Descriptive statistics with Duncan's multiple analysis range test comparing different facial profiles.

Variable	Facial profiles	No.	Mean	SD	SE	Minimum	Maximum	Duncan's groups**
Soft tissue facial convexity*	Concave	2	.0000	.0000	.0000	.00	.00	A
	Straight	22	1.0000	.0000	.0000	1.00	1.00	B
	Slightly convex	23	2.0000	.0000	.0000	2.00	2.00	B
	Convex	28	2.9643	.1890	3.571	2.00	3.00	B
	Total	75	2.0133	.8775	.1013	.00	3.00	
n–me	Concave	2	131.8750	1.5910	1.1250	130.75	133.00	A
	Straight	22	119.4309	9.7592	2.0807	105.56	136.85	B
	Slightly convex	23	121.8513	6.5267	1.3609	110.98	136.60	B
	Convex	28	119.8950	8.0982	1.5304	105.45	134.31	B
	Total	75	120.6783	8.2562	.9533	105.45	136.85	
tr–n	Concave	2	63.1750	1.1667	.8250	62.35	64.00	A
	Straight	22	61.5095	10.1599	2.1661	39.37	80.41	A
	Slightly convex	23	63.1974	8.2694	1.7243	50.99	78.95	A
	Convex	28	62.4893	7.3394	1.3870	41.93	76.01	A
	Total	75	62.4373	8.3515	.9643	39.37	80.41	
n–sn	Concave	2	66.0800	1.3011	.9200	65.16	67.00	A
	Straight	22	55.1541	4.4242	.9433	46.84	62.01	B
	Slightly convex	23	55.9817	2.8873	.6020	51.18	64.31	B
	Convex	28	56.6768	3.9607	.7485	48.90	65.03	B
	Total	75	56.2677	4.1036	.4738	46.84	67.00	
sn–me	Concave	2	65.3500	.9192	.6500	64.70	66.00	A
	Straight	22	64.7650	6.9795	1.4880	54.55	80.67	A
	Slightly convex	23	69.5496	6.0486	1.2612	55.54	79.81	A
	Convex	28	67.2136	6.8550	1.2955	54.20	80.87	A
	Total	75	67.1620	6.7400	.7783	54.20	80.87	
pn–pog(OVD)	Concave	2	59.1200	1.2445	.8800	58.24	60.00	A
	Straight	22	66.1395	6.7954	1.4488	55.33	76.55	B
	Slightly convex	23	68.0422	4.8720	1.0159	58.67	75.39	B
	Convex	28	67.7868	6.5440	1.2367	54.04	80.36	B
	Total	75	67.1508	6.1850	.7142	54.04	80.36	
pn–pog(RVD)	Concave	2	64.4050	1.9870	1.4050	63.00	65.81	A
	Straight	22	68.1543	6.7288	1.4346	56.67	78.43	A
	Slightly convex	23	70.5891	5.2927	1.1036	60.07	80.55	A
	Convex	28	69.8268	6.3266	1.1956	56.39	82.33	A
	Total	75	69.4254	6.1219	.7069	56.39	82.33	
Free way space	Concave	2	7.2850	.4031	.2850	7.00	7.57	A
	Straight	22	2.0150	2.1321	.4546	–4.89	4.80	B
	Slightly convex	23	2.5470	.9099	.1897	1.40	5.16	B
	Convex	28	2.0400	2.3520	.4445	–8.57	6.00	B
	Total	75	2.3280	2.0727	.2393	8.57	7.57	

*Facial convexity: 0=concave, 1=straight, 2=slightly convex, 3=convex; ** Different letters mean significant difference ($p \leq 0.05$); OVD=occlusal vertical dimension; RVD=rest vertical dimension.

Table (4) describes the correlation coefficient among all the variables for males, females and total sample separately, of most important, is the positive highly significant correlation of pn–pog (OVD) and pn–pog (RVD with n–me, sn–me for males, females and total sample.

Also the positive significant correlation of free way space with n–sn for total sample.

Table (4): The correlation coefficient among all the variables for males, females and total sample.

Variable	Sex	Facial convexity	n–me	tr–n	n–sn	sn–me	pn–pog(OVD)	pn–pog(RVD)	Free way space
Soft tissue facial convexity	T							0.356**	
	M								
	F								
n–me	T			0.345**		0.321**	0.709**	0.725**	
	M			0.688**	0.571**	0.282*	0.726**	0.680**	
	F			0.474*	0.419*	0.730**	0.724**	0.693**	
tr–n	T		0.345**			0.266*	0.328**	0.329**	
	M		0.688**						
	F		0.474*			0.393*			
n–sn	T						0.292*	0.343**	0.240*
	M		0.571**						
	F		0.419*						
sn–me	T		0.321**	0.266*			0.717**	0.737**	
	M		0.282*				0.706**	0.725**	
	F		0.730**	0.393*			0.633**	0.611**	
pn–pog(OVD)	T		0.709**	0.328**	0.292*	0.717**		0.952**	
	M		0.726**			0.706**		0.958**	
	F		0.724**			0.633**		0.930**	
pn–pog(RVD)	T	0.356**	0.725**	0.329**	0.343**	0.737**	0.952**		
	M		0.680**			0.725**	0.958**		
	F		0.693**			0.611**	0.930**		
Free way space	T				0.240*				
	M								
	F								

*Correlation is significant at p ≤0.05 level; **Correlation is highly significant at p ≤0.01 level. OVD=occlusal vertical dimension, RVD=rest vertical dimension.

In Table (5), the correlation coefficient among all the facial profiles for total sample also reveal different correlation among the variables.

Of most important, is the positive significantly high correlation of pn–pog (OVD) and pn–pog (RVD) with n–me, sn–me for convex and straight profiles.

Table (5): The correlation coefficient among all the facial profiles for total sample.

Variable	Facial pofiles	Facial convexity	n–me	tr–n	n–sn	sn–me	pn–pog (OVD)	pn–pog (RVD)	Free way space
Soft tissue facial con-vexity	**Convex** **Straight** **Concave**								
n–me	**Convex** **Straight** **Concave**			0.399*	0.646**	0.798** 0.837**	0.751** 0.744**	0.779** 0.716**	
tr–n	**Convex** **Straight** **Concave**		0.399*			0.392*	0.468**	0.450**	
n–sn	**Convex** **Straight** **Concave**		0.646**			0.331*	0.450*	0.507*	
sn–me	**Convex** **Straight** **Concave**		0.798** 0.837**	0.392*	0.331*		0.794** 0.689**	0.825** 0.691**	
pn–pog(OVD)	**Convex** **Straight** **Concave**		0.751** 0.744**	0.468**	0.450*	0.794** 0.689**		0.951** 0.981**	
pn–pog(RVD)	**Convex** **Straight** **Concave**		0.779** 0.716**	0.450**	0.507*	0.825** 0.691**	0.951** 0.981**		
Free way space	**Convex** **Straight** **Concave**								

*Correlation is significant at $p \leq 0.05$ level; **Correlation is highly significant at $p \leq 0.01$ level. OVD=occlusal vertical dimension, RVD=rest vertical dimension.

DISCUSSION

In Table (1), soft tissue profile convexity is significantly greater in females indicating tendency of females to have more convex profile than males. The remaining variables are significantly greater in males reflecting sexual dimorphism between sexes. This is in contrast to results of Joson[34] for young adult Filipinos who found that the combined male and female subjects showed a convex profile.

According to subtelny[33], the soft tissue profile grows more convex with age ,despite the tendency of the skeletal profile to straighten out. The profile angle is one measurement that exhibits some gender dimorphism with regard to optimal esthetics. More esthetically pleasing male faces tend toward a straight profile ,but some degree of concavity that comes with a prominent chin is considered attractive. More esthetically pleasing female faces tend toward a mild convexity, with a softer chin[35].

In this study, in the profile view a general harmony of the forehead, midface and the lower face exists with the lower face height is slightly larger than upper and middle facial heights for total, males and females.

According to Margolis[35], one should focus on the proportions of the face rather than the absolute size. The ideally proportioned face can be divided vertically into equal thirds.

Analysis of variance comparing different facial profiles in Table (2) and Duncan's multiple analysis range test (Table 3)

reveals that n–sn and sn–me and free way space significantly differs among the three facial profiles, with concave facial profiles reporting the larger means, while pn–pog (OVD) is significantly smaller in in this face type ($p \leq 0.05$). This is true since concave face profiles are having long face with increased anterior facial heights. Also this is indicating different growth pattern in these profile types. tr–n , on the other hand, non significantly differs giving clue to the fact that the cranial base developed early and less subjected to effect of other environmental factors that affect growth of facial skeleton.

Arat and Rübendüz[36] in their longitudinal study of changes in dentoalveolar and facial heights during early and late growth periods showed that the differential growth in condylar, sutural and alveolar structures is particularly influential in terms of vertical development of facial characteristics, and alveolar structure plays a compensatory role in establishing sagittal and vertical heights.

The variations in the vertical dimensions are significant when identifying facial types. Therefore, it is important to define the multidimensional combinations in order to make a more accurate identification of the facial types because the interrelation of the anteroposterior and vertical relationship is responsible for the various facial types.

As presented in Table (4), of most important is the correlation of pn–pog (OVD) and pn–pog (RVD) with n–me and sn–me for males, females and total sample, this is true since any increase in total facial height and lower facial height associated with increase in both (OVD) and (RVD). Also is the correlation of free way space with n–sn for total sample.

According to Williams and Wilkin[38], decrease in rest vertical dimension may or may not accompany a decrease in occlusal vertical dimension; it may occur without a decrease in occlusal vertical dimension in patients with a preponderant activity of the jaw–closing musculature, as in patients with muscular hyper tenseness or in chronic gum chewers; increase in rest vertical dimension may or may not accompany an increase in occlusal vertical dimension; it sometimes occurs after the removal of remaining occlusal contacts, perhaps as a result of the removal of noxious reflex stimuli. However, determination of rest vertical dimension by individual dentists using phonetics and swallowing had wide variations in two of the five patients in a range of up to 6 mm[39].

In Table (5), the correlation coefficient for the studied variables among all the facial profiles for total sample also reveals important correlation of pn–pog (OVD) and pn–pog (RVD) with n–me, sn–me for convex and straight profiles. So any increase in total facial height and lower facial height is associated with increase in both (OVD) and (RVD). However, a study have suggested the jaw–muscle spindle as the receptor responsible for regulating and maintaining the occlusal vertical dimension (OVD)[40].

CONCLUSIONS

From this study, the spatial relationships among various vertical facial heights and the dimensional proportions of different facial profiles in young Iraqi adult students were noticed. The significant differences between males and females for all the studied variables were observed. The different interrelationships among the studied parameters were found which are important parameters that should be understood by the clinician who is planning the appropriate orthodontic therapy for such subjects.

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