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ORIGINAL RESEARCH

The Impact of Craniofacial Skeletal Patterns on Sleep Quality and Oral Health-Related Quality of Life Among Adults

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Purpose: This study aimed to assess the possible impact of sagittal and vertical skeletal patterns on sleep quality and oral health-related quality of life (OHRQoL).

Patients and Methods: Following the acquisition of their written informed consent, 330 patients who applied for orthodontic treatment and who met the inclusion requirements were invited to take part in the study by completing the following questionnaires: Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI), and Oral Health Impact Profile (OHIP-14). According to criteria like incomplete questionnaires, BDI score above 17 and body mass index higher than 30, 50 patients' data were excluded. Two hundred and eighty participants were classified according to their sagittal and vertical patterns and the hyoid bone distance to the mandibular plane (GoGn) and anterior cranial base (SN). Oral health-related quality of life and its components, sleep quality and its components were compared between groups.

Results: The PSQI scores for the sagittal and vertical groups did not significantly differ from each other, except for the normodivergent and hyperdivergent groups' total scores. It was observed that when the Hyoid-SN line distance decreased; the sleep quality decreased with an increase in the "sleep disturbance" and "daytime dysfunction". Neither the Hyoid-GoGn distance nor vertical or sagittal patterns were found to be related to OHRQoL. There was a significant correlation between OHIP-14 and PSQI.

Conclusion: Our findings showed that various vertical and sagittal craniofacial features would not affect the OHRQoL scores. PSQI scores appear to be unaffected by the sagittal pattern, but a significant difference was noted in the total score between groups formed considering the vertical pattern.

Keywords: sleep quality, oral health, orthodontics, quality of life

Introduction

The investigation of the impact of malocclusions and facial skeletal patterns on various dimensions of physical, psychological and social well-being remains an ongoing and prominent research area of interest. There are numerous research concerning the craniofacial morphological characteristics of patients with obstructive sleep apnea however there is not enough evidence to show the association between sleep quality and craniofacial skeletal patterns among healthy people.[1,2] Assessment of sleep quality is important for researchers and clinicians, since the lack of quality sleep may cause many physical and mental disorders.[3] There is convincing evidence that sleep quantity and quality affect human health: sleep quality and quantity have been associated with increased risk of cancer,[4] cardiovascular outcomes,[5] increased body mass index,[6] and all-cause mortality. Sleep is influenced by physical activity,[7] stress, and depression, which is a common emotional tendency that often includes physiological changes such as appetite, energy, psychomotor functioning, and concentration.[8]

Sagittal classification is evaluated according to the position of the upper and lower jaws relative to each other and to the cranial base of the skull. Malocclusions have been classified as Class I, Class II, or Class III based on the maxillo-mandibular relationship in the sagittal direction.

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Besides the sagittal discrepancies variations in vertical growth are also the source of diversity. Depending on the growth direction, individuals may have a long or short face. An excessive amount of growth in the vertical dimension can cause a long face with incompetent lips and a gingival smile.[9] On the contrary, a deficiency in vertical growth may lead to insufficient display of incisors, increased mentolabial sulcus, and a short face.[10] SN-GoGn and FMA were found to be the most reliable indicators in assessing facial vertical growth/skeletal pattern.[11]

Malocclusion is neither a disease nor a life-threatening condition but an association has been reported in the literature between the malocclusion/orthodontic treatment need and poor oral health-related quality of life (OHRQoL) and evidence shows that they coexist in the same population.[12] Although there is an interest in the relationship between the malocclusion and OHRQoL, insufficient research has been conducted on the relationship between malocclusion and sleep quality.

The purpose of this study was to evaluate the potential effect of different vertical and sagittal skeletal patterns of the face on sleep quality and OHRQoL in adult patients.

The null hypothesis states that people with various vertical and sagittal craniofacial features would not differ in their OHRQoL scores or sleep quality.

Materials and Methods

This study was approved and followed by the Bezmialem Vakif University Non-Interventional Clinical Research Ethics Committee (E-54022451-050.05.04–73,986). In their application to the ethics committee, the researchers pledged to follow the World Medical Association's Declaration of Helsinki guidelines when conducting this study.

The study group consisted of the patients who applied for orthodontic treatment at Bezmialem Vakif University's Department of Orthodontics between September 2022 and October 2023 and who met the inclusion requirements. Participants gave verbal information about the study, and after receiving their verbal consent, they signed the written informed consent forms that were approved by the ethics committee. All patient data were anonymized to ensure confidentiality.

The inclusion criteria included being older than 18 years of age, having a cephalometric x-ray, having no reported psychiatric diseases, having no obstructive sleep apnea (OSA), and having no craniofacial syndrome. All the patients had their restorative treatments completed and they were checked for periodontal health status. Patients who had previous orthodontic/orthopedic treatment were not included in the study. The following were the exclusion criteria: patients with a body mass index (BMI) of 30 or above, patients with missing questionnaire data, and patients who scored higher than the borderline clinical depression threshold on the depression screening instrument. Obesity (BMI: ≥ 30 kg/m2) is associated with poor sleep quality, as evidenced by higher scores on the Pittsburgh Sleep Quality Index (PSQI).[13] The internationally recognized Beck Depression Inventory (BDI) scale was used as it is a simple depression tendency screening tool, and data from individuals with a depression score above 17 were not included in the study because depression has been found to have a negative effect on sleep quality.[14]

According to the power analysis based on a previous study,[15] with a 95% confidence level and 80% power (mean score difference of 5 units, standard deviation of 10 units), 84 patients are required for each group. Considering possible exclusions, surveys were administered to a total of 330 patients. Following the achievement of a minimum sample size for each group considering sagittal classification, patient recruitment was discontinued. Considering the exclusion criteria, the data of 10 patients who did not fill out every page of the questionnaires were excluded from the study. Thirty-four patients with a score above 17 on the BDI as well as 6 patients whose BMI was 30 or above were excluded from the study. The number of the final sample in the study was 280 (Figure 1).

Data Collection

The participants completed the questionnaires individually in a quiet room, ensuring privacy and minimizing external distractions. The questionnaires were presented by a single researcher (DY). The participants read and answered the questions by themselves. No time limit was imposed during the administration process, allowing participants to respond at their own pace. The demographic data including information such as gender, age, height, and weight was requested in the questionnaire. The ANB (A point-Nasion-B point) and the FMA (Frankfort Plane-Mandibular Plane) were measured

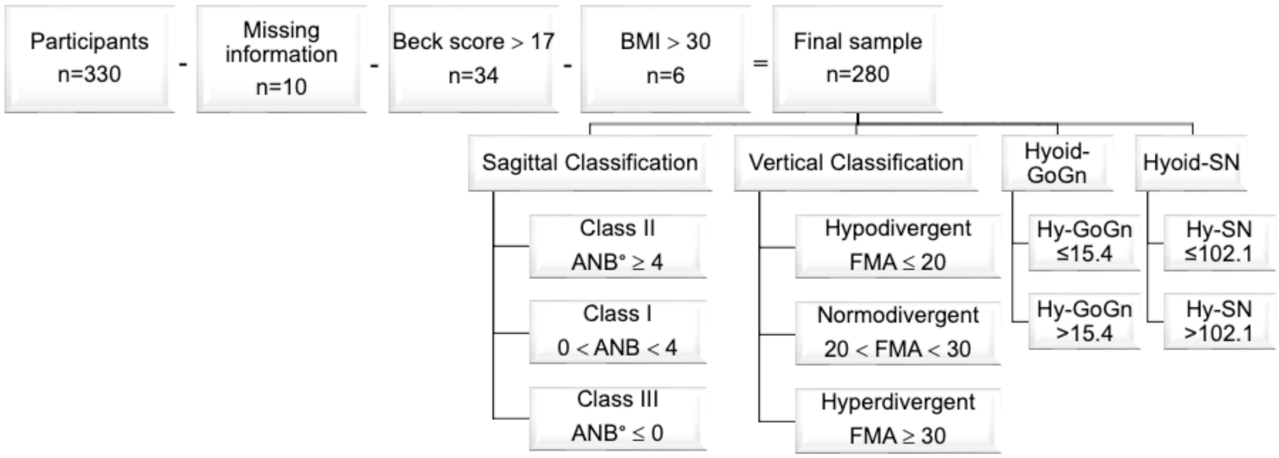

Figure 1 Flow chart outlining the inclusion criteria and the sagittal and vertical skeletal classifications.
Abbreviations: BMI, Body Mass Index; ANB, A point-Nasion-B point; FMA, Frankfort Plane-Mandibular Plane; Hy, Hyoid; GoGn, Gonion-Gnathion; SN, Sella-Nasion.

on the cephalometric radiographs. The distance between the most superoanterior point of the hyoid bone to the mandibular plane (GoGn; Gonion-Gnathion) and anterior cranial base (SN; Sella-Nasion) lines were measured (Figure 2). All the measurements were made by a single researcher (DY) using the WebCeph™ software (Dental Imaging Software Version 1.5.0, Gyeonggi, Korea). To determine the method error, 30 randomly selected cephalograms were re-traced by the same author after 3 weeks. Intraoperator correlation coefficients were found to be between 0.90 and 0.95.

The sagittal classification of the participants was made based on the ANB value, as Class I relationship (0 < ANB < 4), Class II relationship (ANB° ≥ 4), and Class III relationship (ANB° ≤ 0). The vertical classification was made considering the FMA° as normodivergent (20 < FMA < 30), hypodivergent (FMA ≤ 20) and hyperdivergent (FMA ≥ 30).

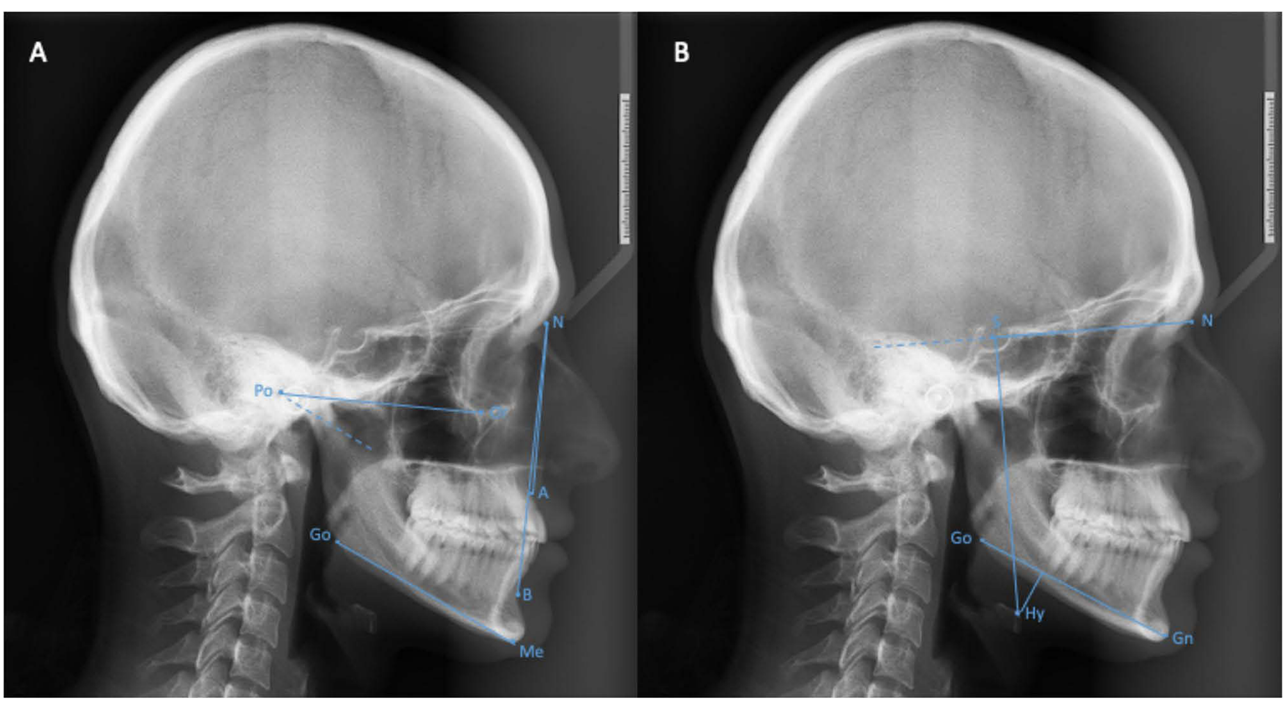

Figure 2 Cephalometric parameters (**A**) Skeletal angular parameters: ANB: A point-Na: Nasion-B point, FMA: Frankfort Plane (Po: Porion - Or: Orbita), mandibular plane (Go: Gonion – Me: Menthon), (**B**) Vertical distance of the hyoid to the GoGn and SN planes (Go: Gonion - Gn: Gnathion and the S: Sella – N: Nasion-line).

Apart from the sagittal and vertical classification, the sample group was further classified based on two criteria associated with the hyoid bone. The entire group's mean values were calculated for the Hyoid distance to the GoGn and SN lines (15.4mm and 102.1mm respectively) and the sample group was split into two based on whether the values of the individuals were above or below the mean.

Questionnaires

Participants who had lateral cephalometric radiographs taken as part of the standard orthodontic records (photos, cast models, and radiographs) were asked to complete three separate questionnaires. The first questionnaire assessed the depression tendency; BDI (not reproduced/adapted). The interpretation based on the BDI scores is as follows; 0–10 points no depression; 11–16 points mild depression, 17–20 borderline clinical depression, 21–30 points moderate depression, 31–40 points severe depression, 41 and above points very severe depression.[16] In our study, the 17-point threshold was accepted to form the sample. The validity and reliability study of the Turkish translation was conducted by Hisli et al[17] (Cronbach's alpha = 0.80, r = 0.93).

The Pittsburgh Sleep Quality Index, a scale in the public domain, is the second survey that participants are asked to fill out (PSQI) aiming to assess the quality of sleep. The PSQI is a 24-item scale that measures sleep disturbances along 7 domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Scores from these seven components are added together to form the total score. The given responses are based on the experiences of the previous month.[18] The reliability and validity of the Turkish version of PSQI were checked by Agargun et al (Cronbach's alpha = 0.804, r = 0.98).[19]

The last questionnaire was the Oral Health Impact Profile 14 (OHIP-14) which is the short version of the original 49-item scale OHIP (Slade G, Oral Health Impact Profile, Wiley Publishers). The results are evaluated with a 5-point Likert scale. The feedbacks were assessed using a 5-point Likert scale: 0: Never, 1: Rarely, 2: Sometimes, 3: Often, 4: Very often. The OHIP-14 questionnaire is evaluated under seven domains and its validity has been verified.[20] All the domains are formed with two questions including functional limitation (1st and 2nd questions), physical pain (3rd and 4th questions), psychological discomfort (5th and 6th questions), physical disability (7th and 8th questions), psychological disability (9th and 10th questions), social disability (11th and 12th questions), and handicap (13th and 14th questions). Following the evaluation of the results for each of the seven domains, the sum of the scores was used to determine the total OHIP-14 score. After the results are calculated separately for seven subgroups, the total score is calculated by adding all the scores together. Since the OHIP scale addresses the problems reported by patients, the lower values indicate a higher oral health-related quality of life.[20] The Turkish translation of the OHIP-14 was found reliable, repeatable, valid and understandable.[21]

Statistical Analysis

The statistical significance level was determined as 0.05. Analyses were performed using MedCalc Statistical Software Version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013). Mean + Standard Deviation is given for parameters suitable for normal distribution and median (minimum-maximum) values are given for parameters not suitable for normal distribution.

The Chi-Square test was used for analyzing the relationship between gender and Classes I, II, and III. The difference between three different skeletal patterns in the sagittal and vertical planes was examined with the Kruskal–Wallis test. Post-hoc comparisons between pairs of skeletal patterns were analyzed with the Mann–Whitney *U*-test with Bonferroni correction only when Kruskal–Wallis test revealed significant differences. The difference between the two groups based on Hyoid bone distance was examined with the Mann–Whitney *U*-test. The correlation between the scores of the two questionnaires was analyzed with the Spearman Rho correlation coefficient.

Results

The final sample included 280 patients, 109 men and 171 women (Figure 3). There was no statistically significant difference among the groups considering the age parameter. Class III patients exhibited a statistically significant higher BMI compared to Class II patients (p = 0.032). No significant difference in BMI was detected between Class I and Class

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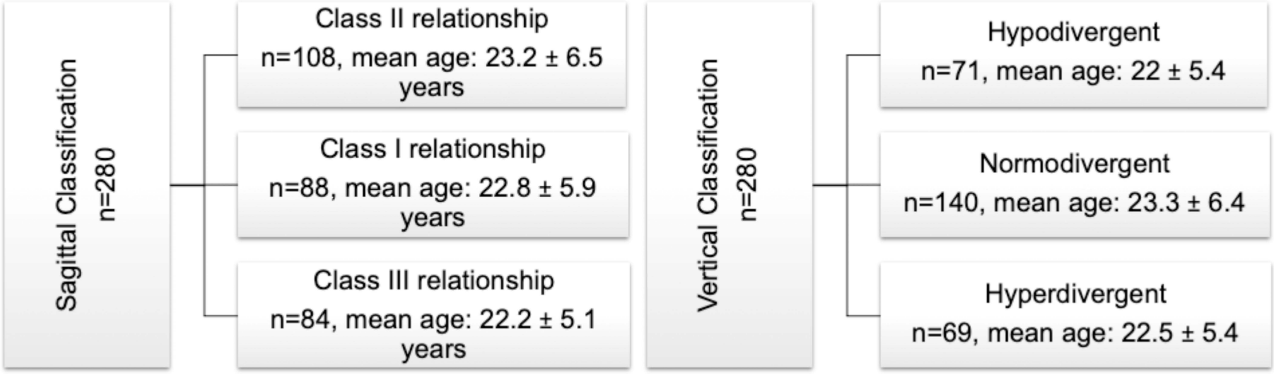

Figure 3 Sagittal and vertical classification of the study group.

II patients (p = 0.252), nor between Class I and Class III patients (p = 1). There was a significant difference between the normodivergent and hypodivergent groups considering the gender, there was a bigger percentage of female participants in the normodivergent group (p = 0.001). There was a significant difference between Class II and Class III groups considering the gender, there was a bigger percentage of female participants in Class II group (p=0.001). 142 subjects showed Hy-to-GoGn≤15.4 and 138 subjects showed Hy-to-GoGn distance>15.4. 148 subjects exhibited a Hyoid-to-SN distance of ≤102.1, while 132 subjects had a Hyoid-to-SN distance exceeding 102.1.

Quality of Sleep

Quality of sleep was assessed using the PSQI questionnaire. The distribution of Pittsburgh survey scores among the Class I, II, and III groups is given in Table 1. The score differed between groups only in the fifth component which is the sleep disturbance. However, the post hoc evaluation revealed no statistically significant difference in pairwise comparisons.

In the comparison of the Pittsburgh survey scores for groups having different vertical patterns, a statistically significant difference was observed only in the total scores (Table 1). Pairwise post-hoc analysis revealed a statistically significant difference specifically between the hyperdivergent and normodivergent groups (p = 0.044).

The components and total score of the Pittsburgh questionnaire exhibited no statistically significant difference between the two groups formed based on the Hyoid-to-GoGn distance. The scores for the fifth (p=0.008) and seventh (p=0.030) components, as well as the total score (p=0.023), were found to be significantly higher in the group where the Hyoid bone is closer to the SN-line when comparing the scores in the two groups based on Hyoid-to-SN distance (Table 1).

Oral Health-Related Quality of Life

Oral health-related quality of life was measured using the OHIP-14 questionnaire. The comparison of the OHIP-14 questionnaire scores between the Class I, II, and III groups revealed statistically significant differences in the first component which is the functional limitation (p = 0.022) and the total score (p = 0.036, Table 2). Subsequent post-hoc analysis revealed that the difference in the first component is attributed to the significance between the Class I, and Class III groups (p = 0.032). No statistical significance was observed in the pairwise comparisons of the total score.

No statistically significant difference was found in the comparison of the OHIP-14 survey's scores for the individual components, nor the overall total score between individuals having different vertical patterns and between the two groups formed considering the Hyoid-to-GoGn distance (Table 2).

After the comparison of OHIP-14 scores based on the Hyoid-to-SN distance, the score for the second component (physical pain) of OHIP-14 was significantly increased as the hyoid bone's proximity to the SN line decreased (p = 0.007, Table 2).

There is a weak and statistically significant correlation between the OHIP-14 and the Pittsburgh total scores (r = 0.329, p < 0.001, Table 3).

Table 1 Comparison of the Quality of Sleep (Pittsburgh Survey Scores)

	Class I n=88	Class II n=108	Class III n=84	p[1]	Normo Divergent n=140	Hypo Divergent n=71	Hyper Divergent n=69	p[1]	Hy-SN ≤102.1 n=148	Hy-SN >102.1 n=132	p[2]	Hy-GoGn ≤15.4 n=142	Hy-GoGn >15.4 n=138	p[2]
1. Sleep Quality				0.313				0.311			0.157			0.301
Mean±SD	1.1±0.6	1±0.6	1±0.6		1.1±0.6	1±0.6	1±0.5		1.1±0.6	1.0±0.6		1±0.6	1.1±0.6	
Med (min-max)	1(0–3)	0.6(0–2)	1(0–3)		1(0–3)	1(0–2)	1(0–2)		1(0–3)	1(0–3)		1(0–3)	1(0–3)	
2. Latency				0.135				0.109			0.425			0.309
Mean±SD	1.2±0.8	1.3±0.9	1±0.8		1.3±0.9	1.1±0.8	1±0.8		1.2±0.9	1.1±0.8		1.2±0.8	1.2±0.9	
Med (min-max)	1(0–3)	1(0–3)	1(0–3)		1(0–3)	1(0–3)	1(0–3)		1(0–3)	1(0–3)		1(0–3)	1(0–3)	
3. Duration				0.310				0.262			0.913			0.653
Mean±SD	0.6±0.9	0.6±0.8	0.8±0.9		0.7±0.9	0.7±0.9	0.5±0.7		0.7±0.9	0.6±0.9		0.6±0.8	0.7±0.9	
Med (min-max)	0(0–3)	0(0–3)	0.5(0–3)		0(0–3)	0(0–3)	0(0–3)		0(0–3)	0(0–3)		0(0–3)	0(0–3)	
4. Sleep Efficiency				0.192				0.468			0.120			0.470
Mean±SD	0.5±0.9	0.6±0.9	0.4±0.9		0.6±1	0.5±0.8	0.4±0.7		0.6±1	0.4±0.8		0.5±0.9	0.5±0.8	
Med (min-max)	0(0–3)	0(0–3)	0(0–3)		1(0–3)	0(0–3)	0(0–3)		0(0–3)	0(0–3)		0(0–3)	0(0–3)	
5. Disturbance				0.030				0.793			0.008			0.570
Mean±SD	1.2±0.6	1.4±0.6	1.2±0.6		1.3±0.5	1.3±0.7	1.3±0.6		1.4±0.6	1.2±0.6		1.3±0.6	1.3±0.6	
Med (min-max)	1(0–3)	1(0–3)	1(0–2)		1(0–3)	1(0–3)	1(0–2)		1(0–3)	1(0–2)		1(0–3)	1(0–3)	
6. Use of Medication				0.204				0.624			0.136			0.832
Mean±SD	0.02±0.2	0.1±0.4	0.1±0.4		0.1±0.4	0.1±0.4	0.01±0.1		0.1±0.4	0.03±0.2		0.1±0.4	0.04±0.3	
Med (min-max)	0(0–2)	0(0–3)	0(0–3)		0(0–3)	0(0–2)	0(0–1)		0(0–3)	0(0–2)		0(0–3)	0(0–3)	
7. Daytime Dysfunction				0.453				0.603			0.030			0.496
Mean±SD	0.8±0.8	1±0.8	0.9±0.9		1±0.9	0.9±0.7	0.9±0.9		1±0.9	0.8±0.8		0.9±0.9	0.9±0.8	
Med (min-max)	1(0–3)	1(0–3)	1(0–3)		1(0–3)	1(0–2)	1(0–3)		1(0–3)	1(0–3)		1(0–3)	1(0–3)	
Total				0.179				0.041			0.023			0.174
Mean±SD	5.5±2.6	5.9±2.8	5.4±3.2		6±3	5.4±2.9	4.9±2.4		6±3	5.2±2.5		5.5±3	5.7±2.7	
Med (min-max)	5(1–12)	5.5(1–15)	5(1–15)		6(1–15)	5(1–12)	5(1–13)		5(1–15)	5(1–13)		5(1–15)	5(1–14)	

Notes: [1]Kruskal Wallis test [2]Mann Whitney *u*-test, $p<0.05$.
Abbreviations: SD, Standard deviation; Med, Median.

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Table 2 Comparison of the Quality of Life (OHIP-14 Survey Scores)

	Class I n=88	Class II n=108	Class III n=84	p[1]	Normo Divergent n=140	Hypo Divergent n=71	Hyper Divergent n=69	p[1]	Hy-SN ≤102.1 n=148	Hy-SN >102.1 n=132	p[2]	Hy-GoGn ≤15.4 n=142	Hy-GoGn >15.4 n=138	p[2]
1. Functional limitation				0.022				0.554			0.540			0.340
Mean±SD	1.1±1.3	1.2±1.4	1.7±1.5		1.3±1.5	1.4±1.5	1.2±1.1		1.4±1.4	1.3±1.4		1.2±1.3	1.4±1.5	
Med (min-max)	1(0–6)	1(0–6)	1(0–6)		1(0–6)	1(0–5)	1(0–4)		1(0–6)	1(0–6)		1(0–6)	1(0–6)	
2. Physical Pain				0.106				0.682			0.007			0.951
Mean±SD	1.9±1.7	2.6±2	2.6±2.1		2.2±2	2.6±1.9	2.5±1.9		2.8±2	2.2±1.9		2.5±1.8	2.5±2.1	
Med (min-max)	2(0–7)	2(0–8)	2.5(0–8)		2(0–8)	3(0–8)	2(0–8)		2(0–8)	2(0–8)		2(0–8)	2(0–8)	
3. Psychological discomfort				0.109				0.311			0.389			0.755
Mean±SD	2.8±1.6	3.4±1.8	3.1±2		3.1±1.7	3.2±2.1	3.2±1.9		3.2±1.8	3±1.9		3.1±1.8	3.2±1.9	
Med (min-max)	3(0–6)	3.5(0–8)	3(0–8)		3(0–8)	3(0–8)	3(0–8)		3(0–8)	3(0–8)		3(0–8)	3(0–8)	
4. Physical disability				0.932				0.980			0.063			0.138
Mean±SD	1.2±1.4	1.3±1.4	1.4±1.8		1.2±1.4	1.5±1.9	1.2±1.4		1.4±1.5	1.2±1.6		1.3±1.4	1.3±1.7	
Med (min-max)	1(0–6)	1(0–6)	1(0–8)		1(0–6)	1(0–8)	1(0–5)		1(0–6)	1(0–8)		1(0–6)	1(0–8)	
5. Psychological disability				0.043				0.580			0.117			0.156
Mean±SD	1.3±1.6	1.9±1.9	1.9±1.9		1.8±1.9	1.5±1.5	1.8±2		1.9±2	1.5±1.7		1.6±1.8	1.9±1.9	
Med (min-max)	1(0–6)	2(0–8)	1(0–8)		1(0–7)	1(0–6)	1(0–8)		1(0–8)	1(0–8)		1(0–8)	1(0–8)	
6. Social disability				0.506				0.752			0.500			0.988
Mean±SD	1±1.3	1.2±1.7	1.4±1.6		1.2±1.6	1.1±1.4	1.3±1.7		1.2±1.7	1.2±1.4		1.2±1.5	1.2±1.6	
Med (min-max)	1(0–6)	1(0–8)	1(0–8)		1(0–8)	1(0–6)	1(0–8)		1(0–8)	1(0–6)		1(0–8)	1(0–8)	
7. Handicap				0.485				0.986			0.311			0.211
Mean±SD	0.6±0.9	0.8±1.4	1±1.4		0.7±1.3	0.8±1.1	0.9±1.4		0.7±1.2	0.9±1.4		0.7±1.2	09±1.4	
Med (min-max)	0(0–4)	0(0–8)	0(0–7)		0(0–8)	0(0–5)	0(0–7)		0(0–8)	0(0–7)		0(0–7)	0(0–8)	
Total				0.036				0.437			0.116			0.986
Mean±SD	9.9±6.3	12.4±8.1	13.1±8.7		11.5±8.1	12.1±7.7	12.1±7.6		12.4±7.8	11.2±7.9		11.5±7	12.1±8.7	
Med (min-max)	9(0–31)	12(0–45)	11.5(0–40)		10(0–45)	13(0–36)	11(1–39)		11.5(0–45)	10(0–39)		11(0–39)	10.5(0–45)	

Note: [1]Kruskal Wallis test, [2]Mann Whitney *u*-test, $p<0.05$.
Abbreviations: SD, Standard deviation; Med, Median.

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Table 3 The Correlation Between OHIP-14 and Pittsburgh Survey Scores

		Pittsburgh Total Score
OHIP-14 Total Score	Correlation Coefficient	0.329**
	Sig. (2-tailed) p value	<0.001
	N	280

Note: Spearman Rho **Correlation is significant.

Discussion

Sleep quality is a multifactorial phenomenon influenced by psychological parameters such as depression,[14] physiological aspects like craniofacial structures[22] and environmental elements including, such as obesity[13] and nutrition.[7] Our study aimed to elucidate the effects of the vertical and sagittal skeletal facial patterns on sleep quality and OHRQoL. In our study, we excluded participants demonstrating symptoms of depression based on BDI scores and those with a BMI greater than 30 to minimize the influence of depression and overweight factors on sleep quality. A comprehensive study exploring both the sagittal and vertical features of the face has not been covered according to our literature review.

Sleep questionnaires offer discrete approximations of the actual sleep quality, but they are primarily subjective. Direct objective measurements of the sleep duration and quality are actigraphy and polysomnogram. Sleep questionnaires can, however, convey the patient's emotions toward their sleep and they are inexpensive, long-lasting at home, and provide helpful supplementary information about patient's natural sleep environments.[23] Pittsburgh Sleep Quality Index was used in the present study. Strong positive evidence for validity and reliability as well as moderate positive evidence for structural validity testing were found for the Pittsburgh Sleep Quality Index across a range of clinical and non-clinical samples.[24]

Baik et al[25] noted several cephalometric characteristics, including retrognathia, micrognathia, and skeletal Class II tendency, among patients with OSA. Moreover, they noted a steeper mandibular plane angle in patients having OSA compared to the control group. In an epidemiologic study with 1000 subjects, craniofacial skeletal patterns of OSA-diagnosed subjects were compared with non-OSA subjects using lateral cephalograms. The cephalometric evaluation showed a difference in maxillomandibular relationship that ANB values are higher in the OSA group, which means there are more Class II subjects in the OSA group.[26]

In Kim et al's research[27] involving 1226 OSA patients, a classification in the sagittal and vertical planes was made. The study found no significant differences in the polysomnographic, symptomatic, or comorbid variables among patients with different skeletal patterns. In our study, we did not find any significance between different sagittal features, but better sleep quality was noted for hyperdivergent patients. The difference between the results can be attributed to the fact that Kim et al and Baik et al referred to a group with existing sleep problems. On the other hand, healthy individuals having no OSA history were included in the present study. Additionally, another study compared the sleep quality among orthodontic patients with different divergencies.[28] Both normodivergent and hyperdivergent groups had high sleep quality and low risk of OSA, with no significant intergroup differences. Moreover, pretreatment-to-posttreatment changes in the pharyngeal airway space were found to be not correlated with sleep quality or the risk of OSA.

Regarding the quality of sleep, the airway volume should be considered a significant component.[29] Nasopharyngeal airway space and upper posterior airway space measurements were reported to be larger in low angle subjects compared to high angle individuals according to Ucar et al.[30] Hyperdivergent facial type is also found to be more common for the OSA groups in comparison to controls.[31] However, in contradiction with those findings, hyperdivergent patients exhibited better sleep quality compared to the normodivergent patients in our study. This contradiction may be attributed to the inclusion of patients without OSA in our study. Additionally, other factors beyond the airway volume, such as the tone of the muscles surrounding the airway and soft tissue volumes, can hypothetically be more favorable in non-OSA hyperdivergent individuals. Although soft tissue characteristics were not examined in our study, these factors may have contributed to the observed outcomes. Additionally, hypodivergent people are more likely than normodivergent people to suffer from sleep bruxism[22] and sleep bruxers showed noticeably higher levels of sleepiness on the Epworth Sleepiness

Scale, which might be interpreted as lower quality sleep.[32] These factors may be linked to hyperdivergent people's higher sleep quality scores in our study.

The hyoid bone position is also an important parameter while evaluating the airway and OSA tendency.[25] Ghosh et al[26] determined that the hyoid bone has a more inferior position in OSA patients by measuring its distance from the mandibular plane. Additionally, the inferior positioning of the hyoid bone was also reported as a factor related to OSA by Baik et al.[25] Jadoul et al reported that the distance between the hyoid bone and the mandibular plane was, on average, 11.3 mm in the OSA group and 11 mm in the control group among non-obese patients, but this difference was not statistically significant.[33] In our study, we did not identify a statistically significant difference between the groups, whether the Hyoid-to-GoGn distance was above or below the average in a matter of sleep quality or OHRQoL scores. Among the two linear parameters related to the Hyoid bone considered in the present study, a significant difference was only found in the group where the hyoid is closer to SN; the group having a superior position of the hyoid presented decreased sleep quality with more sleep disturbance and daytime dysfunction. Our results may have differed from theirs since they performed the study on a group whose OSA had already been diagnosed. The hyoid bone was reported to have a more inferior position in hyperdivergent patients compared to normodivergent control group.[34] In our study the group of hyperdivergent patients demonstrated better sleep quality, as well as the group having a lower hyoid position. These results underline the study's internal consistency, establishing a link between hyperdivergent traits, an inferior position of the hyoid bone and enhanced sleep quality.

Becker et al[35] define the quality of life as a person's sense of well-being that stems from satisfaction or dissatisfaction with the areas of life that are important for his or her well-being: experience of pain/discomfort, physical function, psychology, and social function. Although there have been previous studies evaluating the correlation between the sagittal malocclusions and the OHRQoL scores, there are few studies based on the effect of the different vertical patterns.[36,37]

Our study's statistical analysis of the OHIP-14 scores showed a significant difference in the groups' total scores when the sagittal relationship was considered, but the group comparisons conducted pairwise analysis indicated that this difference was insignificant. In harmony with our findings, a study comparing the OHIP-14 scores of patients having Class I, II, and III skeletal relationship between the ages of 8 and 15, although differences were found between the scores, these were not statistically significant.[15] Additionally, another study among adults showed no statistically significant differences in the OHIP-14 scores between Class ll and III malocclusion groups.[38] Our findings are similar to these studies both including growing and adult individuals. Even though untreated skeletal malocclusions tend to emerge more intensely with age, based on the findings present in the literature, we may assume that growing or adult patients reported relatively similar difficulty and comfort levels between groups with varying sagittal patterns. In contradiction with these, in another investigation involving a cohort of 64 participants, it was reported that adults with dentofacial deformities, such as Class II and III malocclusions, generally exhibit poorer OHRQoL compared to individuals without such deformities.[39] In our study, while the scores were higher among Class II and III patients compared to Class I patients, the difference did not reach the statistical significance level. The significant difference in the mentioned study can be attributed to the variation in the severity of skeletal deformities since no mention of the skeletal discrepancy is present; a classification was made based on clinical considerations only and no objective cephalometric data was referred.

There was no statistically significant difference observed between the groups based on the vertical dimension; nevertheless, the hyperdivergent group's OHIP-14 scores were insignificantly higher. The individuals presenting hyperdivergent facial types are more likely to self-report lower scores than those with normal facial skeletal patterns, particularly regarding social elements, according to a study comparing the hypodivergent and hyperdivergent facial types in the OHRQoL parameter.[36] This discrepancy could be attributed to potential influence of different sagittal characteristics or craniofacial differences between different ethnic groups.

In our study, we included patients who seek orthodontic treatment and found no difference in OHRQoL between various vertical and sagittal patterns. In the literature, it has been stated that OHRQoL increases with orthodontic treatment and orthognathic surgeries without association to the type of deformity.[40]

Sleep quality and OHRQoL were found to be significantly correlated and former studies in the literature studies support this significance.[41,42]

The strengths of this study lie in its inclusion and exclusion criteria for minimizing the potential impacts of both depression and obesity on OHRQoL and sleep quality. Additionally, the study benefits from the inclusion of patients from a single center, ensuring a homogeneous socioeconomic status among participants. This single-centered study was conducted on a homogeneous sample of adults who were classified based on vertical and sagittal features. The results of this study might have been different if it had been done on different age groups or on people from different ethnic groups with distinct craniofacial traits. Additional study in this area can be planned. There are also some limitations regarding our study. It is worth noting that 38% of the study's participants were male patients. Given the known variations in sleep quality between genders, the unequal distribution of male and female participants could potentially lead to disparities in the study's outcomes.[43] Moreover, gender differences have been observed when comparing the normodivergent and hyperdivergent groups. An equal distribution of genders between these two groups may have been achieved with a higher sample size.

Conclusion

Our study aimed to assess the possible impact of various sagittal and vertical skeletal patterns as well as the position of the hyoid bone on the sleep quality and the OHRQoL in adult patients. The part of the null hypothesis stating that people with various vertical and sagittal craniofacial features would not differ in their OHRQoL scores is accepted. On the other hand, the part that stating that people with various vertical and sagittal craniofacial features would not differ in their sleep quality is rejected.

We can conclude that the sleep quality scores appear to be unaffected by the sagittal pattern, but a significant difference was noted in the total score between groups formed considering the vertical pattern. However, an unequal gender distribution between these groups should be noted considering the possible gender-related effects on sleep quality.

Hyoid-Go-Gn distance was found to be ineffective on the sleep quality. Hyoid bone proximity to the SN line was associated with higher scores for both the total scores and sleep disturbances and daytime dysfunction domains. Additionally, the sleep quality and OHRQoL were found to be correlated.

Data Sharing Statement

Data is available upon reasonable request. Inquiries can be directed to the corresponding author.

Author Contributions

All authors made a significant contribution to the study reported.

DY: Conceptualization, Data curation; Investigation; Methodology; Writing - original draft; Writing - review & editing.

BY: Conceptualization; Data curation; Investigation; Methodology; Supervision; Writing - review & editing.

The authors accepted responsibility for all aspects of the work, agreed on the journal to which the article will be submitted and agreed to the journal's contribution guidelines. Every author gave their approval to the manuscript's final version and agreed to take responsibility and be accountable for the contents of the article.

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Disclosure

The authors have no conflict of interest to declare.

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