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Is Bruxism an Influential Factor on Mandibular Condyle Morphology?

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ABSTRACT

Objective: The objective of this study is to assess condyle morphology through panoramic radiographs and investigate the impact of variables such as bruxism, age, gender, education level, chewing habits, and income level on the morphology of the condyle.

Methods: Condyle morphology was assessed across four categories (bird's beak, diagonal diamond, crooked fingers, and oval) in panoramic radiographs featuring 200 patients in this study. Bruxism, age, gender, education level, chewing habits, and income level were classified based on the responses provided in the questionnaires by the individuals in the study.

Results: Among the 100 bruxist patients, 3 exhibited awake, 41 displayed sleep, and 56 manifested both awake and sleep bruxism. Significant differences were observed in the morphology of the left condyle ($p < .05$). In the 26-40 age group, there was an increase in the appearance of bird's beak, diagonal diamond, and crooked fingers, while the oval condyle's appearance decreased ($p < .05$). Males showed a greater prevalence of bird beak appearance ($p < .05$). A rise in education level correlated with increased occurrences of bird beak, diagonal diamond, and crooked finger appearances ($p < .05$). In the presence of bruxism, there was a statistically higher prevalence of bird's beak and diagonal diamond-shaped condyles ($p < .05$).

Conclusion: The outcomes of this study on condyle morphology are influenced by bruxism, age, gender, and education level. Individuals experiencing both awake and sleep bruxism exhibit a more pronounced impact on condyle morphology. To ascertain a genuine causal relationship, prospective cohort studies are imperative.

Keywords: Mandibular condyle, bruxism, gender, educational status

1. INTRODUCTION

The temporomandibular joint (TMJ) is a diarthrodial joint positioned just in front of the external auditory canal, between the mandibular fossa below the temporal bone and the condyle of the mandible. The TMJ serves to maintain equilibrium among craniomandibular structures. The interplay of occlusion, TMJ, and masticatory muscles contributes to the overall balance within this system. Continuous restructuring of the TMJ is a dynamic process aimed at preserving the mechanical and functional relationship between its articular surfaces (1,2). Temporomandibular disorders (TMD) are prevalent conditions affecting the TMJ, masticatory muscles, and associated structures, marked by pain and limitations in mouth movements. Pain, predominantly arising from the chewing muscles, often prompts suspicion of bruxism as a potential etiological factor. (3).

Bruxism is a repetitive jaw muscle activity characterized by grinding and clenching of the teeth. This detrimental parafunctional habit imposes excessive stress on the stomatognathic system (4). Despite indications of psychosocial, pathophysiological, and environmental factors in its etiology, some argue that bruxism is more physiological than pathological, given its prevalence in the general population. As such, it is believed to have a multifactorial etiology (5). Bruxism manifests in two subtypes: 'Awake Bruxism' and 'Sleep Bruxism' (6,7).

In the literature, TMJ morphology has been investigated through diverse methods, including dry and autopsy human skulls, radiographic examinations, magnetic resonance imaging, computed tomography, and cone beam computed tomography (CBCT) (8). The American Academy of Oral and Maxillofacial Radiology advocates for the use of panoramic radiography to assess the structural components of TMJ, citing its advantages of lower radiation dose and cost in comparison to computed tomography (9).

In cases where there is a discrepancy between occlusion, TMJ, and masticatory muscles, a natural balance ensues. However, this equilibrium may lead to alterations in the foundational elements, manifested through structural changes in the condyle, occlusal issues, muscle tension, and the resulting loads. Internal joint diseases and similar symptoms may arise as a consequence of this balance

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formation. These symptoms may either be inconspicuous or signify an inconsistency, indicating destabilization during the establishment of equilibrium between the newly configured morphological form and function. Consequently, while formulating treatment plans for this region, due consideration should be given to the function of the craniomandibular system and the factors influencing it (10). Moreover, studies in the field of public health highlight that individuals with low socioeconomic status face more health problems, which can impact the morphological structure discussed earlier (11). Therefore, income level and education level may also be effective factors in the craniomandibular system. In this study, in addition to the effects of bruxism, age, gender, and chewing habits on condyle morphology, it was aimed to investigate the accuracy of the stated hypothesis by evaluating the relationship between income level-condylar morphology and education level-condylar morphology.

2. METHODS

2.1. Study Design and Sample

Using the G*Power program (3.1.9.2, Franz Faul, Universität Kiel, Germany), it was ascertained that the study population should be a minimum of 58 individuals, considering actual α= 0.03, α=0.05, and power (1-β) =0.95 at a 95% confidence level (12). In this study, the number of patients was set as 200, with 100 individuals allocated to each group (bruxist and non-bruxist). All participants received detailed information about the study and willingly signed an "Informed Consent Form" if they opted to participate. The study protocol, conducted in adherence to the Helsinki Declaration of Human Rights guidelines, received approval from the Necmettin Erbakan University, Faculty of Dentistry, Noninvasive Clinic Ethics Committee (Approval Number 2022/168).

The research excludes patients with missing teeth, excluding third molars, as well as those with neurological disorders, connective tissue and autoimmune diseases, current use of steroids, muscle relaxants, antidepressants, and narcotic drugs. Additionally, individuals who are pregnant or in a pregnancy status, those who have previously used an intraoral splint for bruxism, those younger than 16 years old, with a history of prior TMJ surgery, major trauma to the TMJ, and dentofacial deformities are also excluded from the study.

The study group comprised 100 bruxists (55 females and 45 males, with a mean age of 32.62 years and an age range of 16–69) and 100 non-bruxists (59 females and 41 males, with a mean age of 37.09 years and an age range of 16–68). These individuals sought routine examinations at the Necmettin Erbakan University, Faculty of Dentistry Oral, Dental, and Maxillofacial Radiology Clinic and were assessed based on the criteria for bruxism outlined by the American Sleep Medical Academy (AASM) in 2014 (13).

2.2. Questionnaire

All participants completed a questionnaire (Table 1) based on sociodemographic, chewing habits, and bruxism self-reports. Education and income level information indicating socio – economic status were defined. In figuring out the education level, it was divided into 4 categories: literate, primary education, high school, and university and beyond, based on the Turkish Education System. The income level, on the other hand, was evaluated in 3 categories, based on the Turkish Ministry of Finance, as below the minimum wage, the minimum wage, and above the minimum wage. Chewing habits were evaluated in three categories: Right, left, and bilateral. The presence of bruxism was examined in three categories: Awake bruxism, sleep bruxism, and both awake and sleep.

Table 1. *Questionnaire*

a. Evaluation of sociodemographic situation and chewing habits	
a.1. Gender	☐ Female ☐ Male
a.2. Age group	☐ 16-25 ☐ 26-40 ☐ 41-69
a.3.Education level	☐ Literate ☐ Primary ☐ High ☐ University and above
a.4. Income level	☐ Below the minimum wage ☐ Minimum wage ☐ Above the minimum wage
a.5. Chewing habits	☐ Right ☐ Left ☐ Bilateral
b. Evaluation of awake bruxism	
b.1. During the last 6 months, have you ever been aware of clenching or grinding your teeth while awake? (Yes / No)	
c. Evaluation of sleep bruxism according to the Diagnostic Criteria of the American Sleep Medical Academy in 2014	
c.1. Have you or anyone noticed that you grind your teeth frequently while you sleep? (Yes / No)	
c.2. Have you noticed that your teeth are wearing down more than they should? (Yes / No)	
c.3. Did you notice any of the following symptoms when you woke up? If your answer is yes. mark it. (Yes / No)	
c.3.a. Feeling of tiredness. stiffness or pain in your jaw after waking up (Yes / No)	
c.3.b. A feeling of clenching of your teeth or pain in the jaw after waking up (Yes / No)	
c.3.c. Pain when waking up at your jokes following waking up (Yes / No)	
c.3.d. Difficulty in mouth opening after waking up (Yes / No)	
c.3.e. After waking up. is there a feeling of contraction in the jaw and moving your lower jaw to relax? (Yes / No)	
c.3.f. Clicking sound from the chin following waking up and then passing (Yes / No)	
Presence of bruxism: ☐ None ☐ Awake ☐ Sleep ☐ Both	

To diagnose sleep bruxism, questions aligned with the AASM Diagnostic Criteria were employed (13). For the diagnosis of active sleep bruxism, c.1. of the criteria in Table 1 was used, and sleep bruxism was coded as present if/or at least one symptom from c.2. and an additional c.3. were present. According to both tests, patients with both sleep and awake bruxism were coded as both awake and sleep.

2.3. Clinical Examination

In addition to the objective findings of bruxism, such as wear on teeth, frequent breakage of restorations, and hypertrophy of the masseter muscle, there are also subjective symptoms, such as pain in the temporomandibular, temporal, and neck regions, as well as waking up ("I wake up while biting my tongue") (14).

In the study, the TMJ, masticatory muscles (including the masseter and temporal muscle anterior parts), and trapezius muscle were examined by palpating them extraorally. The examination focused on muscle stiffness, pain during palpation, limited mouth opening, and deviation. The inspection also assessed the presence of facial asymmetry, a square face, and muscle hypertrophy.

The intraoral examination evaluated the presence of bite marks on the tongue, cheek, and lip, tooth wear, fractures in teeth and restorations, xerostomia, and hypermobility.

As a complement to the clinical examination, the radiographic examination evaluated the presence of hypercementosis, periodontal damage, alveolar ridge resorption, pulpal necrosis, and pulp stones.

According to the bruxism categorization proposed by Lobbezoo et al. (4), patients with bruxism were classified with "probable" bruxism based on the questionnaire and clinical examination.

2.4. Radiographic Evaluation

In this study, all panoramic radiographs were captured using a 2D Veraviewpocs instrument (J MORITA MFG corp., Kyoto, Japan) with parameters set at 70 kVp, 5 mA, and an exposure time of 15 s, in accordance with the manufacturer's guidelines.

Condyle morphology was evaluated in four categories: Oval (Figure 1a), crooked finger (Figure 1b), bird beak (Figure 1c), and diagonal diamond (Figure 1d) shape in panoramic radiographs (15).

A seven-year experienced radiologist (SU) evaluated all condyle morphologies. To assess intra-observer agreement, the evaluations were repeated three times with 2 weeks intervals, blinded to the first measurements. According to Cronbach's alpha analysis, intraobserver agreement was excellent (0.903).

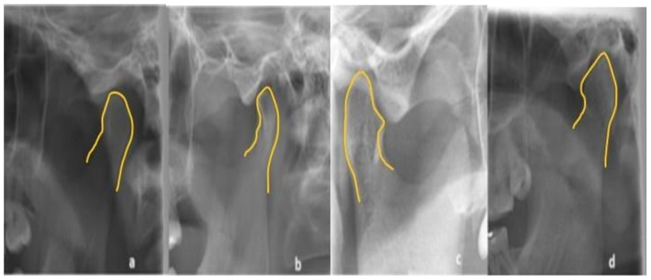


Figure 1. *Types of condyle morphology on panoramic radiography. a. oval; b. crooked finger; c. bird beak; d. diagonal diamond*

2.5. Statistical Analysis

Statistical analysis of the collected data in the study was performed using the IBM SPSS Statistics 22 program (IBM SPSS, Türkiye). The normal distribution of parameters was assessed with the Kolmogorov-Smirnov test, indicating that the parameters did not exhibit a normal distribution. Descriptive statistical methods, including mean, standard deviation, and frequency, were employed to evaluate the study data. The Chi-Square test was utilized for comparing qualitative data, and significance was assessed at the $p < .05$ level.

3. RESULTS

The current study was conducted on 86 males (45 bruxists and 41 non-bruxists) and 114 females (55 bruxists and 59 non-bruxists). The mean age of all individuals was 27±5.7 years (for females 34.36±13.67, for males 35.0±13.75). The distribution of all individuals according to gender, age group, education level, income level, chewing habit, and bruxism status is shown in Table 2. There was no statistically significant difference in the age distribution of individuals based on gender ($p > .05$).

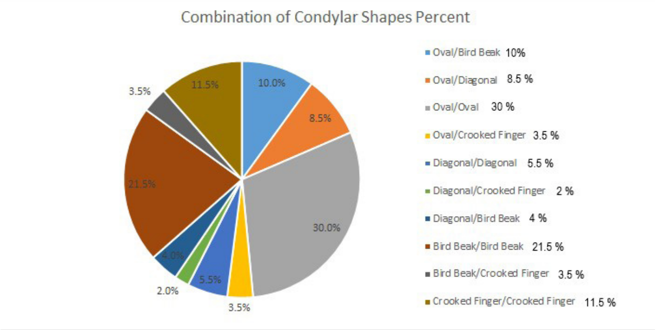


Figure 2. *Combination of the right and left condylar morphology shapes*

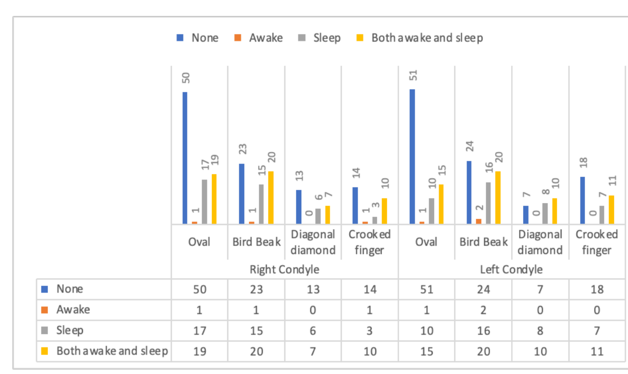
Table 2. *The distribution of parameters according to the condyle morphology*

Parameters	n	%	Right Condyle					Left Condyle				
			Oval	Bird Beak	Diagonal diamond	Crooked finger	p value	Oval	Bird Beak	Diagonal diamond	Crooked finger	p value
Total Sample	200	100.0	87	59	26	28		77	62	25	36	
Gender												
Female	114	57.0	48	29	17	20	.207	46	24	18	26	**.002****
Male	86	43.0	39	30	9	8		31	38	7	10	
Age Groups												
16-25 years	64	32.0	36	15	8	5		37	16	6	5	
26-40 years	76	38.0	28	24	11	13	.287	20	26	12	18	**.009****
40-69 years	60	30.0	23	20	7	10		20	20	7	13	
Education Level												
Literate	1	0.5	1	0	0	0		0	0	1	0	
Primary	45	22.5	17	10	7	11	.127	13	15	5	12	**.018***
High	52	26.0	28	11	8	5		27	15	1	9	
University and above	102	51.0	41	38	11	12		37	32	18	15	
Income Level												
Below the minimum wage	63	31.5	30	16	11	6		29	18	9	7	
The minimum wage	40	20.0	15	10	6	9	.323	15	7	5	13	.056
Above the minimum wage	97	48.5	42	33	9	13		33	37	11	16	
Chewing Habit												
Right	64	32.0	25	19	9	11		24	22	8	10	
Left	36	18.0	17	8	6	5	.821	13	11	6	6	.951
Bilateral	100	50.0	45	32	11	12		40	29	11	20	
Bruxism												
None	100	50.0	50	23	13	14		51	24	7	18	
Awake	3	1.5	1	1	0	1	.396	1	2	0	0	**.016***
Sleep	41	20.5	17	15	6	3		10	16	8	7	
Both awake and sleep	56	28.0	19	20	7	10		15	20	10	11	

** p <.05. ** p <.01*

Figure 2 shows the distribution of the four condyle types evaluated on the right and left sides. A statistical difference was found between the distribution of right and left condyle morphologies (p = .00). The oval shape was dominant on the right, while the bird's beak and crooked finger shape were dominant on the left (Table 2). Further, looking at the combination of right and left condyle shapes, the statistics in Figure 2 showed the most observed combination was oval/ oval with 30%, and the least observed combination was diagonal/ crooked finger with 2%. While right mandibular condyle morphology was not affected by the factor evaluated (p>0.05), differences were detected in left condyle morphology (p <.05) (Table 2). The bird beak appearance was more dominant in males (p <.05) (Table 2). While the appearance of the bird's beak, diagonal diamond, and crooked fingers increased in individuals in the 26–40 age group, the appearance of oval condyles decreased (p <.05) (Table 2). As the education level increased, there was a significant increase in the occurrence of bird beak, diagonal diamond, and crooked finger appearances (p < .05) (Table 2). The effect of chewing habits and income level on condyle morphology could not be determined (p > .05) (Table 2).

Table 3. *The distribution of the right and left condyle shapes according to the presence of bruxism*



Among 100 bruxist patients, 3 exhibited awake bruxism, 41 had sleep bruxism, and 56 had both awake and sleep bruxism (Table 2). No significant differences were observed between gender and bruxism status, education level and bruxism status, income level and bruxism status, or chewing habit and bruxism status (p > .05). However, the presence of bruxism was statistically higher in individuals 26–40 (p = .01). Table 3 shows the distribution of the right and left condyle shapes according to the presence of bruxism. In the presence of bruxism, the presence of the bird's beak and diagonal diamond-shaped condyles was statistically higher ($p < .05$) (Table 2). Multinomial logistic regression analysis, assessing factors influencing left condyle morphology, revealed gender to be significantly more impactful than other factors ($p = .003$).

4. DISCUSSION

This research meticulously delves into the intricacies of mandibular condyle morphology, utilizing panoramic radiographs as a lens to investigate its nuanced relationships with various factors such as bruxism, age, gender, education level, chewing habits, and income level. The comprehensive nature of this study is carefully designed, not only to advance our current comprehension of mandibular condyle morphology but also to unravel the intricate interplay between lifestyle, demographics, and socioeconomic aspects, shaping the anatomical intricacies of the condyle. Through this exploration, we aim to shed light on the subtle yet significant ways in which these diverse factors collectively contribute to the morphological features of the mandibular condyle, thus enriching our understanding of dental anatomy within the realms of individual diversity and broader societal influences.

The etiology, diagnosis, and treatment of bruxism, as well as its effects on teeth, dental implants, and the stomatognathic system, are becoming increasingly popular topics in the medical literature (16,17). There is currently no universally accepted approach to detect bruxism, given its controversial, ambiguous, and subjective nature, with each diagnostic method having inherent limitations (17). Questionnaires while useful in large-scale studies, may introduce subjective biases. Clinical examinations are suitable for broader study groups, but tooth wear alone is not a conclusive indicator of bruxism due to its cumulative nature and various potential differential diagnoses. Although electromyography (EMG) is useful in small populations, its availability is limited. On the other hand, polysomnography (PSG) is the gold standard for identifying sleep disorders but is only suitable for small samples due to its high cost and limited availability (4). Therefore, a recently proposed diagnostic grading system is recommended for both clinical and research purposes in bruxism. This system encompasses possible bruxism (self-report, questionnaires, anamnestic part of a clinical examination), probable bruxism (self-report plus the inspection part of a clinical examination), and definite bruxism (self-report, clinical examination, and a polysomnographic recording, preferably accompanied by audio/video recordings) (4).

The primary objective of this study was to assess the impact of probable bruxism on mandibular condyle morphology relative to other factors. A study by Rompre et al. (18) delved into the efficacy of polysomnography in diagnosing bruxism, establishing clinical criteria for bruxism based on jaw clenching frequency, tooth erosion, soreness, masseter muscle hypertrophy, and morning chewing muscle pain. Significant differences were noted between the bruxism and control groups. However, the cost and complexity of obtaining electromyographic and polysomnographic recordings for bruxism diagnosis present challenges (4). Pintado et al. (19) addressed this by developing a user-friendly questionnaire method, aligning with the clinical diagnostic criteria proposed by Rompre et al. (18). Given the multitude of parameters and the focus on a larger population, our study utilized a questionnaire and clinical examination for bruxism diagnosis. Moreover, this research provides the added advantage of radiographic analysis, enabling a comprehensive evaluation of the relationship between bruxism and the temporomandibular joint.

The temporomandibular joint (TMJ) stands out as a unique joint, characterized by numerous anatomical and functional features that distinguish it from other joints in the human body (20). Anatomically, the TMJ comprises the mandibular condyle, mandibular fossa, articular processes of the temporal bone, and the soft tissue components of the articular disc and joint cavity (1). Developmental variations, remodeling, diseases, trauma, endocrine disorders, and radiotherapy can induce diverse morphological changes in the size and shape of the mandibular condyle (15). The classification of condyle morphology varies across studies, with CBCT tomography commonly categorizing it as round, angled, convex, or flat (20,22,23). A similar classification, involving round, angled, pointed, and straight categories, was employed by Oliveira et al. (24), Sonal et al. (15) and Anisuzzaman et al. (25) adopted a similar condyle shape classification, dividing it into four groups: Oval, bird's beak, diamond, and crooked finger, akin to the current study. This classification was applied after assessing condyle morphology through panoramic radiographs. Panoramic radiographs persist as the primary screening tool for temporomandibular joint (TMJ) abnormalities among various imaging modalities used for TMJ imaging (26). This method is valued for its simplicity, affordability, and ability to assess the bony components of the TMJ. The utilization of panoramic radiography and double TMJ views is justified by their low radiation dose, accessibility, cost-effectiveness, and capacity to offer substantial morphological information about the TMJ. It proves to be a valuable screening method for identifying condylar abnormalities, including erosions, sclerosis, osteophyte development, resorption, and fractures (8). Additionally, by excluding odontogenic causes and other jaw abnormalities, panoramic radiographs provide information about the teeth, mandible, and maxilla, contributing to the comprehensive diagnosis (27).

In this study, 200 pairs of condyles (100 bruxists (55 females and 45 males) and 100 non – bruxists (59 females and 41 males)) were examined on panoramic radiographs. The shape of the condyle was found to be oval (41%), bird's beak (30.25%), crooked finger (16%), and diamond (12.75%), respectively. In similar studies, oval condyle morphology was found to be the most common, which is consistent with our study, while crooked finger was the least common condyle type, which is different from our study (12,15,25). As in this study, Anisuzzaman et al. (25) and Sonal et al. (15) claimed that the bird's beak follows the oval shape. However, according to Al-Sadi et al. (12), diamond condyles (15.67%) were the second most common type of condyle.

In contrast to other studies, this investigation specifically assessed whether the studied factors influenced the morphology of both the right and left condyles. The examined factor did not show a significant effect on the morphology of the right mandibular condyle ($p > .05$). However, changes in the morphology of the left condyle were observed ($p < .05$). Analyzing the temporomandibular joint for typical symmetry features, the oval-oval combination (%30) emerged as the most prevalent, supporting the findings of Sonal et al. (15). and Al-Saedi et al. (12). The oval-oval combination was deemed the most typical, aligning with the outcomes of another research. Conversely, the combination involving crooked fingers was identified as the least common (12,15). This study found that the combination of crooked finger morphology with other morphologies was less common, with the combination of crooked finger and crooked finger ranking third at 11.5%. 50% of individuals who chew bilaterally may explain this. Because the condyle morphologies in combination are oval-oval (30%), bird beak-bird beak (21.5%), and crooked finger-crooked finger (11.5%). After evaluating all the investigated factors, the most frequently observed condyle morphologies on the right and left were the bird beak and crooked finger following the oval morphology. So, with their symmetrical combinations being more common than the diagonal-diagonal combination.

In our study, a significant difference in condylar morphology between males and females was observed (Table 2). While the oval shape was the most common in both genders, the bird's beak appearance was more prevalent in males ($p < .05$) (Table 2). This finding aligns with the conclusions of Maqbool et al. (28) and Al-Saedi et al. (12) Comparable results were reported in a dry skull study by Gindha et al. (29). Contrary to previous studies that found no significant association between condyle shape and age, our study revealed that the appearance of bird's beak, diagonal diamond, and crooked finger increased, while oval condylar appearance decreased in individuals aged 26 to 40 years ($p < .05$) (Table 2) (12,22,23,25,30). This difference in results from other studies on this topic is noteworthy. When the region and culture where the research was conducted are examined, it can be revealed that the age range of 26–40 is the period in which individuals may experience the highest level of stress. Therefore, it can be assumed that the study results stem from the rise in parafunctional habits triggered by heightened stress and anxiety. The main reasons for this include factors such as graduation, job search, marriage, care of dependents, financial concerns caused by increasing expenses, and the effort to balance both materially and spiritually between work and private life. Additionally, the following paragraphs delve into these scenarios, examining the correlation between income level-condyle morphologies and education level-condyle morphologies.

While the overall results of this study align with previous research, it contributes to the field by exploring relationships between financial status and condyle morphology, as well as educational level and condyle morphology topics not extensively investigated in the literature. A significant correlation was found between condyle morphology and educational level. Specifically, bird beak, diagonal diamond, and crooked finger appearances increased with higher education levels ($p < .05$) (Table 2). This novel insight adds a valuable dimension to our understanding of the factors influencing condyle morphology. However, at this point, it should be considered that since there is no significant difference between economic status and condyle morphology, there may be individual differences in economic level, quality of life, and enjoyment of life. This represents one of our study's limitations. Although almost 50% of the individuals in the study have an economic level of minimum wage or above, the absence of a statistically significant difference shows that there is no decrease in stress levels at the same rate. Tang (31) presents findings that corroborate this assertion in his research on the correlation between income level and quality of life. Tang (31) establishes in his study that there is a positive correlation between income level and the quality of life of individuals. Nevertheless, when he included a criterion of "love of money" in the research, he noticed a negative association between income level and quality of life. It reveals that the obsession with making money affects happiness, satisfaction, and quality of life. On the other hand, the existence of a significant difference with increasing education levels can be attributed to the fact that they do not have the same economic earnings as their peers with lower education levels, nor do they have similar or even more expenses such as accommodation, transportation, and education. Furthermore, the fear of graduating, achieving success, and securing a job, along with the perception of lagging behind peers in life, could potentially link to heightened stress and dysfunctional behaviors, ultimately explaining the outcomes of the study. Robotham and Julian (32) offer evidence for this scenario, referencing a direct relationship between stress levels and the number of students in their comprehensive literature review. Their review covers various aspects of student stress, including factors such as academic pressure, exam stress, financial burdens, the transition to university, and stress related to studying.

Upon thorough literature review, no studies were identified that describe the normal condyle shape in relation to individual chewing patterns. In contrast, Singh et al. (8) reported a statistically significant association ($p = .003$) between chewing behavior and bilaterally similar condyle morphology. In this study, the round shape was more prevalent in individuals with undetermined chewing habits and those with bilateral chewing habits. Singh et al. (8) categorized condyle shape morphologies according to Chaudhary's classification (33), revealing that the majority of participants had no detectable chewing habits, with 120 (68%) exhibiting bilateral round condyles, 51 (29%) demonstrating bilateral chewing habits, 2 (1%) displaying unilateral left habits, and 3 (2%) having unilateral right habits. Similar findings were reported by Halicioglu et al. (34).

Indeed, there is limited research exploring the association between bruxism and condyle morphology in the literature. Singh et al. (8), in their study examining condyle morphology and parafunctional habits based on Chaudhary's classification (33), observed a higher incidence of bilaterally comparable round condyles in patients without parafunctional habits. Notably, all subjects with parafunctional habits exhibited differences in their condyles. Tao et al. (35) reported similar findings. Our study aligns with the results of Singh et al. (8) and Tao et al. (35). Specifically, a robust association between bruxism and condyle morphology was identified in our investigation, with a statistically higher presence of bird's beak and diagonal diamond condyles in individuals with bruxism ($p < .05$). In contrast, Mortazavi et al. (36) mentioned in their systematic review, the meta-analysis of articles that considered both types of bruxism (awake bruxism and sleep bruxism) did not show a significant association between bruxism and TMJ. These varying outcomes highlight the complexity of the relationship between bruxism and condyle morphology.

Acknowledging the limitations of this study, it is important to note that the demographic studied may not be entirely representative of the entire Turkish population. Enhancing the study's generalizability could be achieved by including a larger and more diverse study group from various locations, ensuring a more homogeneous distribution across factors such as gender, age group, chewing habits, and bruxism. Additionally, factors like different malocclusions, prior bruxism treatment, treatment techniques, duration, and orthodontic treatment could influence mandibular condyle morphology. Including these parameters in future studies could enhance the meaningfulness of the results. Despite these limitations, the study contributes valuable information to the existing body of knowledge.

5. CONCLUSION

In conclusion, this study highlights that various factors such as bruxism, age, gender, and educational level can influence condyle morphology. The observed changes in individuals experiencing both awake and sleep bruxism suggest a more comprehensive impact on condyle morphology than previously understood. Our study offers valuable insights into these complex interactions and underscores the urgent need for prospective cohort studies to further explore cause-and-effect relationships. Such research is crucial for developing effective interventions. Therefore, this study establishes an important foundation for future investigations into the factors affecting condyle morphology.

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Research idea: GM

Design of the study: GM, SU

Acquisition of data for the study: SU

Analysis of data for the study: GM

Interpretation of data for the study: GM, SU

Drafting the manuscript: GM, SU

Revising it critically for important intellectual content: GM

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