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Evaluation of the prevalence of malocclusion in individuals applying for orthodontic treatment in the Turkish community: A cross-sectional study

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Abstract

Aim: This study aimed to determine the prevalence of different types of dental and skeletal malocclusions among individuals seeking orthodontic treatment and to evaluate the relationship between these classifications.

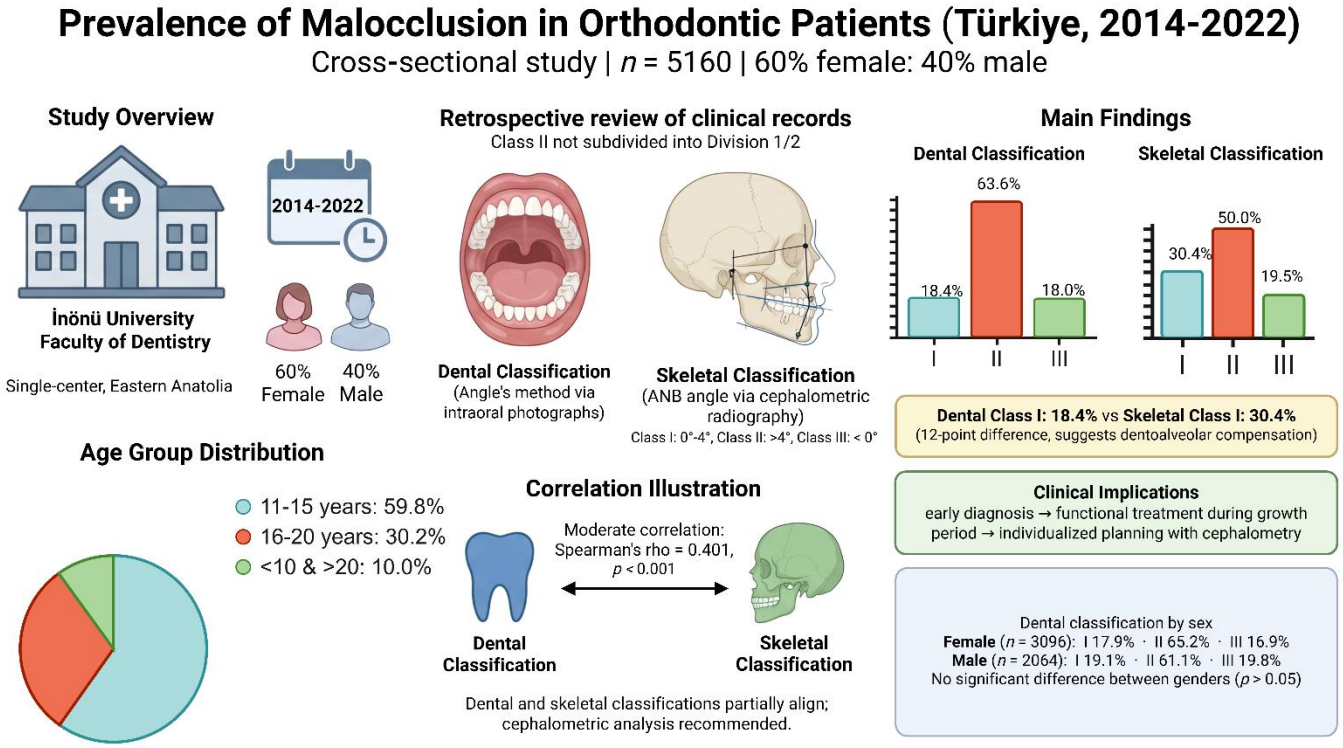
Methodology: This retrospective cross-sectional study included 5160 individuals (3096 females and 2064 males) who presented for orthodontic consultation and had complete clinical records, including intraoral examinations and lateral cephalometric radiographs. Dental malocclusions were classified according to Angle's classification system (Class I, II, and III) based on molar relationships. Skeletal malocclusions were determined using ANB angle measurements obtained from cephalometric analyses, with standard values used to categorize patients into skeletal Class I, II, or III groups.

Results: Class II (63.6%) was the most common dental malocclusion, Class I (18.4%) and Class III (18.0%) were less common. In terms of skeletal classification, Class II (50.0%) was the most common, followed by Class I (30.4%) and Class III (19.5%). Malocclusion distributions differed significantly by sex (dental: $p = 0.007$; skeletal: $p < 0.001$), although the effect sizes were negligible. There was a moderate positive correlation between the dental and skeletal classifications (*rho*=0.401, $p<0.001$).

Conclusion: Class II malocclusion was the most prevalent in both dental and skeletal classifications. The relatively similar rates of Class I and Class III in dental classification highlight the need for careful diagnostic assessment. The moderate correlation between dental and skeletal classifications emphasizes the importance of combining occlusal and cephalometric evaluations to inform individualized treatment planning.

Keywords: Angle's classification, cephalometry, dental occlusion, epidemiology, malocclusion, prevalence

Graphical abstract



Introduction

Malocclusion is defined as irregular dental alignment (1). It occurs when the upper teeth are misaligned with the lower teeth in the transverse, anteroposterior, or vertical planes (2). Malocclusion is among the most common oral health conditions and has a high prevalence worldwide (3, 4). This is considered a manifestation of increased biological variation. The need for treatment is often driven by both psychosocial concerns and established oral health risks associated with malocclusion (5). Individuals who are satisfied with their facial appearance reportedly have higher levels of self-confidence and self-esteem (6). Malocclusion may impair various oral functions, including chewing, swallowing, and speaking (7).

According to the World Health Organization, malocclusion is considered the third most significant oral health priority worldwide (8). Unlike many medical and dental conditions, malocclusion is typically the result of variations in normal development rather than a pathological process. Although its etiology cannot be attributed to a single factor, it is widely accepted that malocclusion arises from multifactorial causes (2).

A clearer understanding of the physical, social, and psychological impacts of malocclusion is important in various aspects. This perspective not only enhances awareness of how malocclusion affects individuals' daily lives but also clarifies the motivations for seeking orthodontic treatment beyond strictly clinical indications (9-11). Orthodontic interventions can begin in early childhood and are often concentrated during the eruption of permanent teeth and in adolescence (9). It is reasonable to assume that untreated malocclusions during childhood and adolescence may negatively influence an individual's psychological well-being and overall quality of life (12).

Several studies have provided epidemiological data on the prevalence of malocclusion in different populations (13, 14). In general, these studies employed quantitative variables alongside Angle's classification system. Additionally, various treatment need indices based on criteria such as aesthetic impairment, potential negative effects on oral health, and deviations from normal occlusion have been used to assess the necessity for orthodontic intervention (15).

Epidemiological studies on the prevalence of malocclusions provide essential data for planning and optimizing orthodontic treatment strategies. For this purpose, several studies have been conducted to investigate the prevalence of malocclusion in Türkiye (14, 16). A review of the relevant literature shows that most of these studies employed the Angle dental classification, while a few others utilized skeletal classification methods (17-20). Unlike previous studies, the present study incorporated both dental and skeletal classification systems and evaluated the correlation between them.

The aim of this study was to determine the prevalence of different types of dental and skeletal malocclusions among individuals seeking orthodontic treatment and to evaluate the relationship between these classifications. The distribution of dental and skeletal malocclusion classifications according to gender was also examined. While many studies have focused solely on the Angle dental classification, the concordance or discrepancy between the skeletal structure and dental occlusion is often overlooked. Moreover, most existing studies are limited by small sample sizes and are restricted to specific regions in Türkiye. To address these gaps, the present study utilized a large sample and incorporated both dental and skeletal classifications to provide a more comprehensive and regionally relevant assessment of the prevalence of malocclusion in orthodontic patients. These findings may contribute to a better understanding of regional malocclusion patterns and may provide useful information for orthodontic service planning and resource allocation.

The null hypotheses of this study were that there is no statistically significant association between dental and skeletal malocclusion classifications and that the distribution of malocclusion types is not significantly associated with gender.

Materials and Methods

Ethical approval for this study was obtained from the Non-Interventional Clinical Research Ethics Committee of İnönü University (Approval No: 2024/6906, Date: 17/12/2024). This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki (2024).

This retrospective, cross-sectional, descriptive study aimed to evaluate the prevalence of malocclusion in individuals who presented for orthodontic treatment. This study was conducted using archival clinical records collected between 2014 and 2022.

The study population included individuals who applied to the Department of Orthodontics at the Faculty of Dentistry, İnönü University, from 2014 to 2022. The study sample included 5160 Turkish individuals (3096 females and 2064 males) with complete clinical documentation, including intraoral and extraoral photographs, lateral cephalometric radiographs, and anamnesis forms.

This study was designed as a retrospective, cross-sectional design. Rather than employing a systematic sampling method, the sample comprised individuals who sought orthodontic treatment and had complete clinical records available in the institutional archive.

Clinical records were reviewed, and the patients' gender and age at the time of presentation were recorded. Intraoral photographs were used for dental classification, and lateral cephalometric radiographs were used for skeletal classification.

Angle's classification system was used for sagittal dental relationships. Angle (21) considered the maxillary first molar as the key to occlusion and assumed its position to be fixed. A Class I relationship was defined when the mesiobuccal cusp of the maxillary first molar aligned with the buccal groove of the mandibular first molar. A more distal position of the mandibular first molar indicated a Class II relationship, while a more mesial position indicated a Class III relationship (21). Based on this definition, dental classifications were performed using intraoral photographs.

All records were independently evaluated by two observers (O.K. and H.G.O.). To assess intra-observer agreement, 100 randomly selected records were re-evaluated by O.K. four weeks after the initial assessment. Inter-observer agreement was assessed by comparing the classifications performed independently by O.K. and H.G.O. Agreement was evaluated using Cohen's kappa coefficient, with 95% confidence intervals reported for both intra- and inter-observer agreement.

In this study, skeletal classification was performed using lateral cephalometric radiography. Radiographs were analyzed using digital cephalometric software (Nemoceph; Nemotec, Madrid, Spain). Based on the A point–nasion–B point (ANB) angle measurements, values between 0° and 4° were classified as skeletal Class I, values greater than 4° as skeletal Class II, and values less than 0° as skeletal Class III (22).

Statistical analyses were performed using the SPSS software (Version 30.0.0; IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess the normality of the numerical data. Since the data were not normally distributed, the Mann-Whitney U test was applied for comparisons between two groups (i.e., gender: male and female), and the Kruskal-Wallis test was used for comparisons involving three or more groups (e.g., age groups, skeletal classifications, and dental classification categories). Categorical variables were analyzed using the chi-square test. Statistical significance was set at $p < 0.05$.

Results

A total of 5160 individuals were included in the study, consisting of 3096 females (60.0%) and 2064 males (40.0%). Among participants with available age data, the mean age was 14.44 ± 2.97 years (range: 6.75–35.33 years). Analysis of the age distribution at treatment initiation showed that most participants were between 11 and 15 years (59.8%), followed by those aged 16–20 years (30.2%) (Fig. 1).

The distribution of dental and skeletal malocclusion types according to gender is presented in Tables 1 and 2. Among female participants, 17.9%, 65.2%, and 16.9% had Class I, Class II, and Class III dental malocclusions, respectively. Among male participants, the corresponding proportions were 19.1%, 61.1%, and 19.8%, respectively (Table 1). Class II dental malocclusion was the most prevalent type in both sexes. The distribution

of dental malocclusions differed significantly by sex (x^2 = 9.94, df = 2, p = 0.007); however, the effect size was negligible (Cramér's V = 0.044).

Among female participants, 31.9%, 50.8%, and 17.3% had Class I, Class II, and Class III skeletal malocclusions, respectively. Among male participants, the corresponding proportions were 28.3%, 48.9%, and 22.8%, respectively (Table 2). Class II skeletal malocclusion was the most prevalent type in both sexes. The distribution of skeletal malocclusions also differed significantly by sex (x^2 = 25.11, df = 2, p < 0.001), with a negligible effect size (Cramér's V = 0.070).

The distribution of both dental and skeletal malocclusions differed significantly according to gender. A significant association was observed between gender and dental malocclusion classification (x^2 = 9.94, df = 2, p = 0.007), as well as between gender and skeletal malocclusion classification (x^2 = 25.11, df = 2, p < 0.001). The relationship between dental and skeletal malocclusion classifications was further evaluated using Spearman's rank correlation analysis (Table 3). A moderate positive correlation was observed between the two classifications (rho = 0.401, p < 0.001).

Interobserver agreement was substantial for skeletal (weighted κ = 0.815, 95% CI: 0.684–0.924) and almost perfect for dental classification (weighted κ = 0.954, 95% CI: 0.902–0.984). Corresponding intraobserver agreement was also substantial (κ = 0.860, 95% CI: 0.743–0.953) and almost perfect (κ = 0.953, 95% CI: 0.894–0.989), respectively.

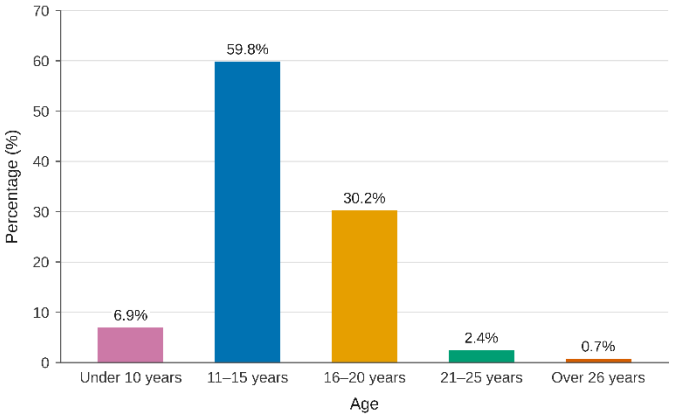


Figure 1. Distribution of age at treatment initiation.

Table 1. Distribution of dental malocclusion by gender.

		Dental Class I	Dental Class II	Dental Class III	Total (n)
Sex	Female	555	2019	522	3096
	%	10.8	39.1	10.1	60.0
	Male	394	1262	408	2064
	%	7.6	24.5	7.9	40.0
Total	Total	949	3281	930	5160
	%	18.4	63.6	18.0	100.0

Percentages are calculated over the total sample (n = 5160).

Table 2. Distribution of skeletal malocclusion by gender.

		Skeletal Class I	Skeletal Class II	Skeletal Class III	Total (n)
Sex	Female	987	1572	537	3096
	%	19.1	30.5	10.4	60.0
	Male	584	1009	471	2064
	%	11.3	19.6	9.1	40.0
Total	Total	1571	2581	1008	5160
	%	30.4	50.0	19.5	100.0

Percentages are calculated over the total sample (n = 5160).

Table 3. Correlation results between dental and skeletal classes.

		Skeletal Classification
Dental Classification	Correlation Coefficient	0.401
	p-value	<0.001
	n	5160

Spearman's rank correlation coefficient was used.

Discussion

Understanding the prevalence of malocclusion at both national and global levels is essential for determining the need for orthodontic treatment and allocating the appropriate resources—such as workforce, clinical expertise, and materials—required to deliver such care. Moreover, prevalence data serve as a rational basis for planning orthodontic service delivery. Evaluating malocclusion patterns across different populations and regions also highlights the influence of both genetic and environmental factors (20).

This study evaluated the orthodontic diagnostic records of 5160 individuals who presented to the Department of Orthodontics at the Faculty of Dentistry, İnönü University between 2014 and 2022. Most patients in the study were residents of Malatya and neighboring provinces, such as Elazığ, Bingöl, and Muş. Therefore, the findings may offer valuable insights into the prevalence of malocclusion and the need for orthodontic treatment in Türkiye's Eastern Anatolia Region.

Among the 5160 patients included in the study, 3096 (60%) were female, and 2064 (40%) were male. These results are consistent with those of previous studies, which commonly reported a higher proportion of female patients seeking orthodontic treatment (19, 23). This gender difference is often attributed to the greater emphasis women place on aesthetics and facial appearance, which increases their likelihood of seeking treatment. Even in different geographic regions, it has been observed that aesthetic concerns are more prevalent among women, which may explain the consistent gender disparity across studies.

When the age distribution at treatment initiation was examined, individuals aged 11–15 years accounted for the largest group (59.8%), followed by those aged 16–20 years (30.2%). A systematic review reported that malocclusion is highly prevalent during childhood and adolescence (24). Similarly, De Ridder et al. (25) emphasized that malocclusion in children and adolescents is widespread and represents a significant global public health concern. More recently, a systematic review of studies published between 2010 and 2024 reported that the prevalence of malocclusion in the primary dentition ranged from 28.4% to 83.9%, with more than half of the included studies reporting prevalence rates above 50% (26).

In our study, the analysis of dental malocclusion prevalence by gender showed that 39.1% of all female participants had Class II, 10.8% had Class I, and 10.1% had Class III malocclusion. Among males, 24.5%, 7.6%, and 7.9% had Class II, I, and III malocclusions. Class II malocclusion was the most common dental classification in both genders.

Globally, Class I and Class II malocclusions have been reported as the most prevalent types, whereas Class III malocclusion and open bite are among the least common (27). In Africa, Class I malocclusion and open bite were the most frequent, while in Europe, Class II malocclusion was more common (27). Similarly, a study conducted in India reported that Class I molar relationship was the most prevalent malocclusion (75.2%), followed by Class II (23%) and Class III (1.8%) malocclusions (28).

In our country, more than one study has been conducted on the prevalence of dental malocclusion in patients presenting for treatment. Sayın et al. (14) reported that the prevalence of Class I malocclusion was 65.65%, Class II division 1 malocclusion was 19.69%, Class II division 2 malocclusion was 3.73% and Class III malocclusion was 10.94% in Isparta region. Sarı et al. (18) reported that Class I malocclusion was seen in 61.7%, Class II division 1 malocclusion in 25.1%, Class II division 2 malocclusion in 3%, and Class III malocclusion in 10.2% of patients in the Konya region. Çelikoğlu et al. (29) reported that normal occlusion was observed in 3.5% of participants, while Class I, Class II Division 1, Class II Division 2, and Class III malocclusions were observed in 41.5%, 28.9%, 9.4%, and 16.7%, respectively, in the Erzurum region. In this respect, different results were seen in our study, and dental Class II malocclusion (63.6%) was found to be more common. This is because in our study, the Class II bite was not divided into two subdivisions but was counted as a single bite, and geographical region, genetics, and environmental factors were thought to affect the different prevalence of malocclusions. Similar to our study, Gelgör et al. (16) reported that normal occlusion was observed in 10.1% of participants, while Class I, Class II Division 1, Class II Division 2, and Class III malocclusions were observed in 34.9%, 40.0%, 4.7%, and 10.3%, respectively, in a study conducted in the Kırıkkale region. Bilgiç et al. (30) reported that Class II Division 1 malocclusion was the most prevalent type among adolescents in a study conducted in the Central Anatolia region of Türkiye.

Although Angle's classification system, a widely used method for assessing dental malocclusion based on the position of the first molars, has been applied reliably for many years, it may be insufficient for fully determining the prevalence of malocclusion (31, 32). Therefore, in the present study, skeletal classification was performed alongside Angle's classification to provide a more comprehensive evaluation. Based on the skeletal assessment, 30.4% of the participants were classified as skeletal Class I, 50.0% as Class II, and 19.5% as Class III. Thus, skeletal Class II malocclusion was the most prevalent skeletal pattern in the study population.

Although studies investigating the prevalence of skeletal malocclusion remain relatively limited, available findings provide useful comparative data. In a study conducted in Mexico involving 428 orthodontic patients, the prevalence of skeletal Class I, Class II, and Class III malocclusions was reported as 53.3%, 37.1%, and 9.6%, respectively (33). In another study conducted in Pakistan, Waheed-ul-Hamid and Asad (34) evaluated cephalograms of 100 patients and reported skeletal Class I, Class II, and Class III malocclusions in 31%, 47%, and 21% of the sample, respectively, while the remaining 1% exhibited bimaxillary retrognathism. These findings, together with the results of the present study, indicate

considerable variation in the distribution of skeletal malocclusion patterns across different populations.

In a study conducted in Türkiye, Çoban et al. (19) reported the prevalence of skeletal Class I, II, and III malocclusions as 46.6%, 35.7%, and 17.7%, respectively. Another study reported these rates as 56.2%, 34.6%, and 9.2% for classes I, II, and III (20). In contrast, the most common skeletal malocclusion type in our study was Class II, with a prevalence of 50.0%.

It has been suggested that the prevalence of skeletal malocclusion may vary across different geographical regions due to genetic, environmental, and ethnic factors (35). Genetic predispositions may influence jaw structure, tooth alignment, and craniofacial growth patterns, thereby affecting malocclusion rates (36). Environmental influences, such as dietary habits (e.g., consumption of hard vs. soft foods), oral parafunctional behaviors (e.g., thumb sucking, lip biting, and tongue thrusting), respiratory conditions, and socioeconomic status, can also contribute to regional variations in malocclusion development (35, 36). Additionally, differences in study methodology, sample size, diagnostic criteria, and data collection techniques may account for discrepancies in the reported prevalence of malocclusion across studies. This finding is likely related to the fact that our study included only individuals who actively sought orthodontic treatment, many of whom may have presented with Class II malocclusion due to aesthetic or functional concerns. Moreover, the relatively high prevalence of Class II malocclusion observed in our study may have been influenced by the collective evaluation of Class II cases without further subdivision into specific subtypes. These aspects highlight the importance of contextualizing prevalence data based on the study design and population characteristics. The differences observed between our results and those reported in the literature may be attributed to regional, methodological, and clinical variations. Therefore, when comparing studies conducted in different geographical regions, it is essential to consider genetic, environmental, and methodological factors to accurately interpret the prevalence of malocclusion.

In the present study, both dental and skeletal classifications were used. This dual approach allowed for the evaluation of malocclusion not only in terms of occlusal relationships but also with respect to the underlying skeletal morphology, thereby providing a more comprehensive diagnostic framework. While many previous studies have relied primarily on Angle's dental classification, skeletal assessments have often been overlooked or addressed independently. However, the combined evaluation of dental and skeletal patterns is clinically significant, as it helps determine whether malocclusion reflects true harmony between the jaw and teeth or arises from dentoalveolar compensation.

In this context, our study differs from previous research by comparatively presenting both dental and skeletal classification data within the same sample group, thereby strengthening the basis for orthodontic diagnosis and treatment planning. A moderate positive correlation was found between the dental and skeletal classifications (Spearman's *rho* = 0.401, $p < 0.001$), indicating a partial but not complete alignment between the two systems.

Notably, differences were observed between the distributions of dental and skeletal classifications, particularly for Class I and Class II malocclusions. Dental Class II malocclusion was observed in 63.6% of the participants, whereas the prevalence of skeletal Class II malocclusion was 50.0%. In contrast, the prevalence of dental Class I malocclusion was 18.4%, compared with 30.4% for skeletal Class I. These findings suggest that some individuals classified as skeletal Class I may exhibit a dental Class II molar relationship. This discrepancy may be related to factors affecting the molar relationship, such as mesial migration of the maxillary molars following premature loss of primary molars or loss of leeway space, as well as differences arising from the classification of borderline or end-to-end molar relationships. However, as these factors were not directly evaluated in the present study, they should be considered possible explanations for the observed discrepancy between dental and skeletal classifications rather than definitive mechanisms.

Such findings suggest that dentoalveolar compensation may sometimes obscure the underlying skeletal pattern, making it difficult to accurately evaluate skeletal relationships based solely on occlusal characteristics. The moderate correlation observed in our study further supports the idea that dental and skeletal classifications should be assessed independently. Therefore, cephalometric analyses should be integrated into treatment planning to enable a more accurate assessment of skeletal discrepancies, growth patterns, and intermaxillary relationships. This approach supports a more informed determination of the need for functional, orthopedic, or surgical interventions and contributes to more effective, individualized treatment outcomes.

One of the primary limitations of this study is that the sample consisted exclusively of individuals seeking orthodontic treatment, which may not accurately reflect the prevalence of malocclusion in the general population. Additionally, the study was conducted at a single center and involved participants from a specific geographical region, potentially limiting the generalizability of the findings to other populations. Furthermore, no standardized orthodontic treatment need index, such as the Index of Orthodontic Treatment Need (IOTN), the Dental Aesthetic Index (DAI), or the Index of Complexity, Outcome and Need (ICON), was applied; therefore, the present findings should not be interpreted as a direct assessment of orthodontic treatment need. Future studies should include broader, more diverse populations from multiple regions and incorporate standardized treatment-need indices to provide a more comprehensive and representative assessment of malocclusion prevalence and orthodontic treatment needs at the national level.

Conclusion

Our study found that Class II malocclusion was the most prevalent type in both dental and skeletal classifications. Although Class III malocclusion was the least common overall, its prevalence was relatively close to that of Class I in the dental classification (18.0% vs. 18.4%). Dental and skeletal malocclusion distributions differed significantly by sex; however, the effect sizes were negligible, suggesting limited practical significance of these differences.

The moderate correlation between dental and skeletal classifications indicates partial, but not complete, agreement between the two classification systems and highlights the importance of incorporating cephalometric assessment alongside occlusal evaluation in orthodontic diagnosis and treatment planning. The findings from this large sample may also contribute to a better understanding of malocclusion patterns among individuals seeking orthodontic treatment and provide useful information for orthodontic service planning and resource allocation.

Disclosures

Ethical Approval: Ethics committee approval was received for this study from the Non-Interventional Clinical Research Ethics Committee of İnönü University, in accordance with the World Medical Association Declaration of Helsinki (2024), with the approval number: 2024/6906.

Peer-review: Externally peer-reviewed.

Author Contributions: Conception — H.G.O.; Design — F.O., H.G.O., O.K.; Supervision — F.O.; Materials — O.K.; Data Collection and/or Processing — H.G.O., O.K.; Analysis and/or Interpretation — H.G.O., O.K., F.O.; Literature Review — F.O., H.G.O.; Writer — H.G.O., F.O.; Critical Review — H.G.O., F.O.

Declaration of Generative AI and AI-Assisted Technologies: During the preparation of this work, FigureLabs was used to create the graphical abstract, and the AI figure-generation feature in BioRender was used for subsequent text edits to the figure. The author(s) then reviewed, edited, and verified all visual and scientific content for accuracy and take(s) full responsibility for the final published material.

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