Journal of Contemporary Dental Sciences

Original Article

Prevalence of Malocclusion in Permanent Dentition among Patients Attending Qassim University Dental Clinics, Saudi Arabia

Rabia Bilal[1], Rahaf Alruhaimi[2]*

[1]Department of Orthodontics and Pediatric Dentistry, College of Dentistry, Qassim University, Buraydah, Saudi Arabia, [2]Department of Orthodontics, College of Dentistry, Qassim University, Buraydah, Saudi Arabia

***Corresponding Author:**
Rahaf Alruhaimi
E-mail: r.alruhaimi@qu.edu.sa

Access the journal online

Website:
https://jcds.qu.edu.sa/index.php/JCDS

e-ISSN: 1658-8207

PUBLISHER: Qassim University

ABSTRACT

Objective: This study investigated the prevalence of malocclusion in the Qassim region of Saudi Arabia.

Methods: This retrospective observational study involved casts from 229 patients who visited Qassim University dental clinics between 2018 and 2021. The casts were divided based on gender and malocclusion. The following occlusal patterns were considered in the study: Class I, Class II, and Class III malocclusions. Occlusal traits such as anterior crossbite, posterior crossbite, open bite, deep bite, and increased overjet were also recorded. In addition, dental anomalies such as hyperdontia, hypodontia, diastema, ectopic eruption, transposition, and peg-shaped teeth were investigated. All measurements were recorded using a Yaluo stainless steel electronic digital display caliper vernier. Data were analyzed using the Statistical Package for the Social Sciences for Windows version 23.

Results: Majority of the patients were female (164, 71.6%), and 65 (28.4%) were male. Class I was the most prevalent occlusion type, with 183 (79.9%), followed by 37 (16.2%) in Class II, and finally, only 9 (3.9%) in Class III. The dental anomalies in the study group, specifically occlusion types, reveal that Class I has the highest percentage of dental anomalies, with 15.8% more than other types.

Conclusion: According to the statistics, the majority of people in Qassim have adequate occlusion, but the prevalence of dental anomalies may make treatment more challenging. As a result, the research on malocclusion frequency is highly valued and crucial for gathering data for a national database and for treatment planning.

Keywords: prevalence; malocclusion; retrospective observational study; dental anomalies; orthodontics

Introduction

In dentistry, occlusion refers to the relationship between the maxillary and mandibular teeth, either in a static rest position or during dynamic movement. An ideal occlusion occurs when this relationship follows normal functional and aesthetic boundaries.[1] Malocclusion, on the other hand, refers to any deviation from normal alignment or improper relationships between the teeth of the upper and lower dental arches on jaw closure. The term "malocclusion" was introduced in the early 1900s by Edward Angle, who is considered the father of modern orthodontics and the pioneer of the first classification system for malocclusion.[2,3] Malocclusion is a multifactorial condition caused by genetic, environmental, or local factors, such as poor oral habits, tooth anomalies, and the developmental position of teeth.[4] Dental anomalies, including impaction, macrodontia, microdontia, hypodontia, and others, may arise due to genetic, hereditary, or environmental factors, affecting tooth number, size, position, and eruption timing.[5] These anomalies can significantly impact occlusal relationships, resulting in crowding, spacing, or sagittal, transverse, and vertical malocclusions, thus complicating orthodontic treatment planning.[6] Consequently, the World Health Organization (1987) included malocclusion among the headings of handicapping conditions.

Dentofacial abnormalities are anomalies that result in disfigurement or interference with function and require treatment; they may adversely affect the patient's physical or emotional well-being.[7-9]

Malocclusion is commonly associated with facial profile disturbances, functional limitations, and reduced psychosocial ability.[10,11] Moreover, it can have a significant social impact on perceived attractiveness, school performance, and employability, particularly when anterior teeth are involved. Therefore, early diagnosis and intervention are crucial to minimize health aberrations and improve the quality of life.[12] Studying malocclusion prevalence is important not only for diagnosis and treatment but also as a scientific and medical document for future generations.[7] To accurately assess malocclusion, a universally accepted classification system is required. Angle established a system based on the molar relationship that remains widely used today. In normal occlusion, molars and other teeth are ideally aligned. The most common type is Class I, in which the mesiobuccal cusp of the maxillary first molar aligns with the mesiobuccal groove of the mandibular first molar; however, other teeth may exhibit crowding, spacing, or irregularities. Class II malocclusion is characterized by the maxillary first molar being positioned anteriorly, with its mesiobuccal cusp occluding in the embrasure between the mandibular second premolar and first molar; it is further subdivided into Division I and Division II, depending on the angulation of the incisors. In Class III malocclusion, the maxillary first molar is positioned posteriorly, with its mesiobuccal cusp occluding in the distobuccal groove of the mandibular first molar.[1,13] Angle's classification became a key qualitative epidemiological tool for assessing malocclusions.[14]

Malocclusion is a multidimensional condition resulting from multiple factors. Accurate epidemiological data are essential for a systematic and well-organized dental care program, as they inform early orthodontic interventions and policy implementation.[15] While adequate prevalence data are available in more developed regions, such information is still lacking in some developing nations.

Furthermore, in most countries, the demand for orthodontic treatment is increasing; therefore, it is essential to plan orthodontic measures on a population basis to assess the resources required for such services. The analysis of malocclusion is also crucial for planning orthodontic or orthognathic surgery, as the type of malocclusion affects appliance selection and treatment outcomes.[16] Several studies have been conducted in various regions of Saudi Arabia.[17,18] Literature reviews indicate that Class I malocclusions are the most prevalent in Saudi Arabia.[12] To the best of our knowledge, no previous studies have discussed the prevalence of malocclusion in permanent dentition in the Qassim region. Therefore, our study spotlights the prevalence and patterns of malocclusion.

Materials and Methods

This retrospective observational study was approved by the Institutional Review Board of Qassim University (Approval No. EA/F-2021-4006). The study included the analysis of 229 dental casts obtained from patients who attended the orthodontic screening clinic at Qassim University dental clinics between 2018 and 2021 seeking orthodontic treatment. The inclusion criteria for the selection of the sample were as follows:

i. Casts in permanent dentition having a complete set of teeth, excluding third molars
ii. Casts in good quality and casts exhibiting all the classes of Angle's occlusion/malocclusion.[13]

All poor-quality casts, casts in primary or mixed dentition, and casts of patients with syndromic clefts were excluded from the study.

The casts were divided based on gender and malocclusion, as shown in Table 1. The following malocclusions were considered:

a. Angle's classification (normal occlusion, Class I, Class II, and Class III malocclusion)[13]
b. Overjet

Table 1: Malocclusion variables and dental anomalies with definitions and normal ranges

Malocclusion Feature	Definition with Measurement/ Normal Range
Classification of malocclusion	Angle's classification of malocclusion.
Overjet	Measured from the labial surface of the most protruded maxillary incisor to the labial surface of the corresponding mandibular incisor; normal range: 0–4 mm
Overbite	Coverage of the mandibular incisor by the most protruded fully erupted maxillary incisor; normal range: 0–4 mm.
Anterior crossbite	One or more of the maxillary incisors occlude lingually to the mandibular incisors, which are classified as present/absent.
Posterior crossbite	One or more of the maxillary molars occlude lingually to the buccal cusps of the opposing mandibular teeth, which are classified as present/ absent.
Dental anomalies	These include hyperdontia (extra teeth), hypodontia (missing teeth), diastema (space between teeth), ectopic eruption (abnormal eruption path), transposition (positional interchange), and peg-shaped teeth, which are classified as present/absent.

Source: Modified from Alharbi[19]

c. Overbite (deep bite and open bite)
d. Crossbite (anterior and posterior crossbite)
e. Dental anomalies such as hyperdontia, hypodontia, diastema, ectopic eruption, transposition, and peg-shaped teeth.

One examiner (a Pakistani fellowship-certified orthodontist) used a Yaluo stainless steel electronic digital display caliper vernier to measure all parameters.

The concordance correlation coefficient test revealed no significant differences when the same observer repeated analysis of 30 casts after a 2-week interval.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences for Windows version 23. Descriptive statistics were used to measure the mean, standard deviation, error, and percentage through charts and graphs. We checked normality for quantitative variables (overjet and overbite) using the Kolmogorov–Smirnov test, box plots, and descriptive statistics. Both variables were not normally distributed and presented using the median, interquartile range (IQR), and minimum and maximum values in addition to the mean and standard deviation. Qualitative variables (gender, occlusion type, presence of crossbite, open bite, deep bite, overjet, and dental anomalies) were presented using frequency and percentages. Groups are compared for occlusion type using quantitative variables, employing the Kruskal–Wallis test, followed by *post hoc* analysis with Bonferroni correction. Pearson's Chi-squared test was applied to compare groups regarding all qualitative variables. The significance level was set at a $P = 0.05$. All tests were two-tailed.

Results

The present study assessed the prevalence of occlusal characteristics of the permanent dentition of 229 patients' casts. Demographic data among the population studied were first recorded. Females numbered 164 (71.6%) and males 65 (28.4%). Concerning occlusion types, 183 (79.9%) were Class I, 37 (16.2%) were Class II, and 9 (3.9%) were Class III [Figure 1].

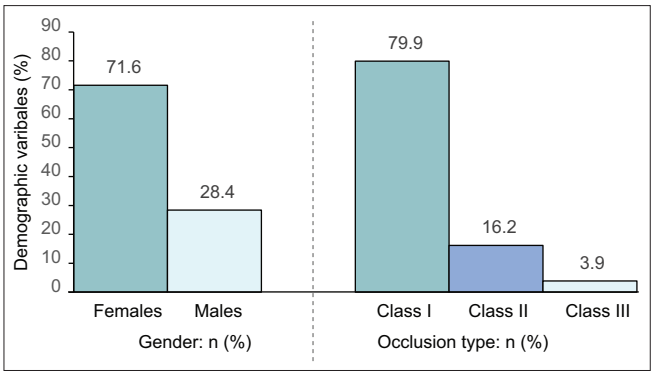

Figure 1: Demographic variables of the study sample

Overjet and overbite

When comparing overjet and overbite among the patients in relation to occlusion type, the median (IQR) of overjet were Class I = 2 (0–8), Class II = 4 (1–14), and Class III = 1 (0–3), while for overbite, Class I = 3 (0–7), Class II = 3 (0–8), and Class III = 1 (0–3), as shown in Figure 2. Similarly, the mean overjet in Class I was 2.68 (1.40), whereas in Class II, it was 5.16 (2.79); in Class III, it was 1.22 (0.83). The difference in the overjet among the occlusion types was statistically significant: Class II shows a bigger overjet than the others. Regarding overbite, the mean of Class I was 2.87 (1.58), for Class II, 3.11 (1.76), and for Class III, 1.22 (0.97). This indicates statistically significant differences in overbite among occlusion types. Class II also shows increased overbite and overjet [Figure 3].

Open bite was present in 12.2% of the study group, and deep bite was present in 32.3% of the study group, with no statistically significant difference [Table 2].

Crossbite

The distribution of crossbite among the study group by occlusion type showed a statistically significant difference. Specifically, Class I showed increased anterior crossbite in 8.7% of the cases and increased posterior crossbite in 12.6% of the cases [Table 3].

Dental anomalies

The dental anomalies in the study group, specifically regarding occlusion types, reveal that Class I has the highest percentage of dental anomalies, with 15.8% more than the other occlusion types. However, this difference is not statistically significant [Figure 4]. The evaluation of the dental anomalies among the study group compared to the occlusion types showed that diastema was the most common dental anomaly (41.2%), and increased with Class I occlusion. Second was peg-shaped lateral incisors (23.5%), and the least common dental anomaly was transposition (5.9%) [Figure 5].

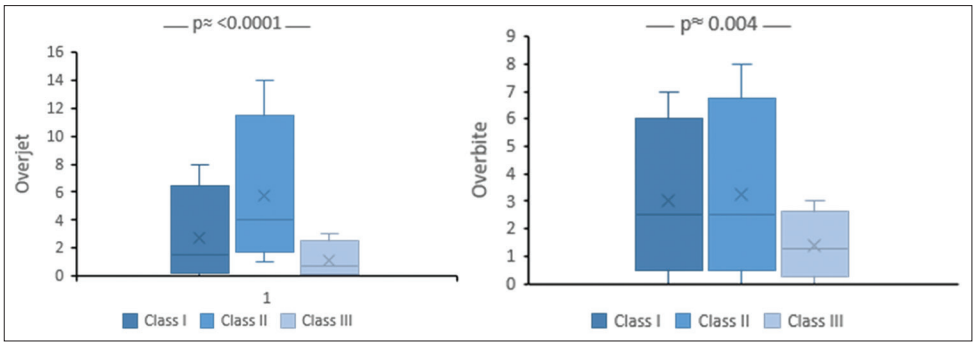

Figure 2: Median (interquartile range) overjet and overbite among the study group

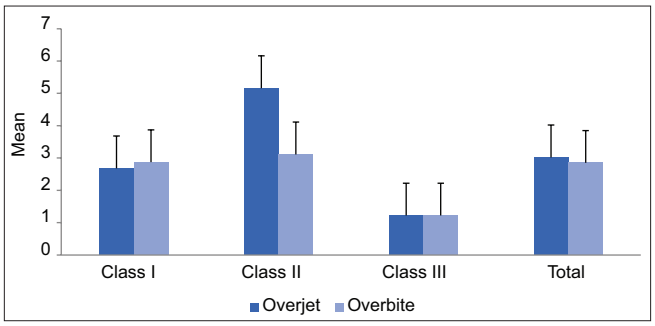

Figure 3: Mean overjet and overbite among the study group in relation to the occlusion type

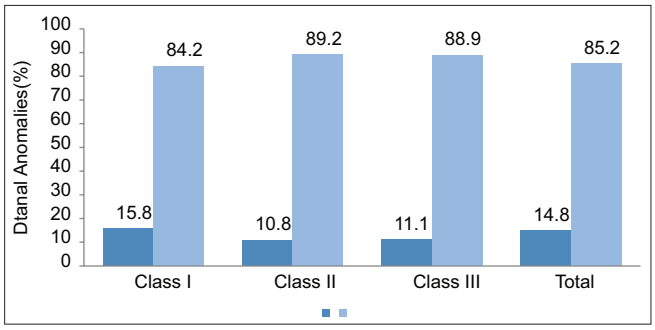

Figure 4: Percentage of dental anomalies among the study group in relation to the occlusion type

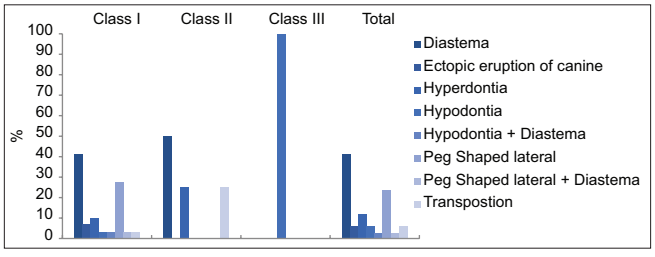

Figure 5: Types of dental anomalies among the study group who presented with dental anomalies, in relation to the occlusion type

Table 2: Distribution of open bite and deep bite among the study group in relation to the occlusion type

Variable	Class I (*n*=183)	Class II (*n*=37)	Class III (*n*=9)	Total (*n*=228)	*P*-value*
		n (%)		*n* (%)	
Open bite					
Yes	21 (11.5)	6 (16.2)	1 (11.1)	28 (12.2)	0.655
No	162 (88.5)	31 (83.8)	8 (88.9)	201 (87.8)	(0.721)
Deep bite					
Yes	59 (32.2)	15 (40.5)	0 (0)	74 (32.3)	5.442
No	124 (67.8)	22 (59.5)	9 (100)	155 (67.7)	(0.066)

*Not a statistically significant difference at $P \geq 0.05$

Table 3: Distribution of crossbite among the study group in relation to the occlusion type

Variable	Class I (*n*=183)	Class II (*n*=37)	Class III (*n*=9)	Total (*n*=228)	*P*-value*
		n (%)		*n* (%)	
Anterior crossbite					
Yes	16 (8.7)	0 (0)	3 (33.3)	19 (8.3)	10.81
No	167 (91.3)	37 (100)	6 (66.7)	210 (91.7)	(0.004*)
Posterior crossbite					
Yes	23 (12.6)	5 (13.5)	4 (44.4)	32 (14)	7.258
No	160 (87.4)	32 (86.5)	5 (55.6)	197 (86.0)	(0.027*)

*Statistically significant difference at $P \leq 0.05$

Discussion

This retrospective observational study was conducted to document the prevalence of malocclusion in the Qassim region of Saudi Arabia. Interpreting the findings of this study requires acknowledging the methodological challenges that often affect research on the prevalence of malocclusion. Differences in sample size, participant age, recruitment criteria, and classification methods can lead to variability among studies. In addition, comparing malocclusion traits across populations remains difficult due to inconsistencies in diagnostic approaches, examiner subjectivity, and study objectives.[12,20] The present study included 65 (28.4%) males and 164 (71.6%) females. A higher number of females than males was also found in studies by Agarwal *et al*.[21] in India and by Khan *et al*.[22] in Pakistan.

For this review, a literature search was conducted using Medline through PubMed, Embase, Web of Science, and Google Scholar databases. Nationwide Prevalence

of Malocclusion Traits in Saudi Arabia: A Systematic Review showed that among the three classes of Angle's malocclusion, normal occlusion, which is Class I, was the most prevalent type, which does not require any treatment.[12] This finding is consistent with our results, as another study conducted in the northern border region of Saudi Arabia by Gudipaneni *et al*.[18] also found Class I to be the most prevalent occlusion. Lin *et al*.[23] found Class I occlusion to be the most prevalent malocclusion in the Chinese population. The same findings were observed by Sayin and Türkkahraman,[24] Agarwal *et al*.,[21] and Shahzad *et al*.[25] for the Turkish, Indian, and Pakistani populations. According to Onyeaso,[26] Class I malocclusion was also reported as the most prevalent type among Nigerian patients. However, Khan *et al*.[22] reported that Class II was the most prevalent malocclusion among the Pakistani population.

Pre-normal occlusion (mesiocclusion), classified as Angle Class III, was the least common type of malocclusion observed in the present study, accounting for only 3.9%. El-Mangoury and Mostafa study[27] on the Egyptian population and reported that Class III malocclusions are most common in oriental populations.

Studies measuring overbite and overjet are limited, and to the best of our knowledge, ours is the first one in Qassim. In general, the present study shows that Class II has the highest measures of overjet and overbite among the malocclusion types. The prevalence of increased overjet in our study was 9.06%, with Class I at 2.68%, Class II at 5.16%, and Class III at 1.22%. Other studies conducted in Saudi Arabia and northern Jordan by Gudipaneni *et al*.,[18] Asiry,[28] and Abu Alhaija *et al*.[29] reported increased overjet at rates of 22.2%, 16.2%, and 24.7%, respectively.

In this study, a lower prevalence of open bite was observed in 11.5% of the cases. Our results were similar to those of Gudipaneni *et al*.,[18] Asiry,[28] and Abu Alhaija *et al*.[29] on Saudi and Jordanian populations: 4.6%, 8.4%, and 2.9%, respectively. Anterior crossbite was observed in 8.7% of subjects. Abu Alhaija *et al*.[29] reported that 1.9% of the Jordanian population had an anterior crossbite, and Gudipaneni *et al*.[18] reported that 4.8% in the northern border region of Saudi Arabia had an anterior crossbite. In our study, the prevalence of posterior crossbite was 12.6%, compared to only 9.4% and 7.1% in studies by Gudipaneni *et al*.[18] and Abu Alhaija *et al*.[29]

Our study reveals a higher prevalence of deep bite (32.2%), similar to the findings of the Saudi study by Gudipaneni *et al*.[18] and Borzabadi-Farahani *et al*.,[30] at 23.4% observed deep bite in 34.5% and 2.2% a very deep overbite.

The association between malocclusion and dental anomalies has not been thoroughly explored in the literature, although dental anomalies potentially complicate orthodontic treatment and necessitate individualized treatment plans.[20] Several previous studies have shown variations in the prevalence rates and types of common dental anomalies, which may be influenced by racial differences, population characteristics, and varying diagnostic methodologies. The available literature also reports inconsistent findings regarding which malocclusion class shows the highest prevalence of dental anomalies, highlighting the influence of population and methodological differences across studies.[31,32] Our study revealed no significant difference between malocclusion and dental anomalies, which is consistent with the findings of Al-Jabaa and Aldrees. This contrasts with the findings of a study conducted in Kosovo.[20,33] In our study, Class I occlusion had the highest number of dental anomalies, including hyperdontia, hypodontia, diastema, ectopic eruption, transposition, and peg-shaped teeth. The most characteristic finding in our study is the maxillary midline diastema between the upper central incisors, which occurs in 41.2% of cases, mainly in association with Class I occlusion. In a study by Thilander *et al*.[34] on the Colombian population, the prevalence of diastemas was reported as 3.7%. Onyeaso study[26] on the Nigerian population reported diastema prevalence as 36.8%. Second to that were peg-shaped lateral incisors, occurring with Class I and Class II. Class III reported no peg-shaped lateral incisors.

This study has several limitations. First, the lack of sufficient literature reporting specific dental anomalies, such as hyperdontia, hypodontia, diastema, ectopic eruption, transposition, and peg-shaped teeth, made it difficult to compare our findings with previous research. Second, the sample was obtained solely from Qassim University dental clinics, which may introduce selection bias and restrict the generalizability of the findings to the broader Qassim population. Finally, while this study provides a broad overview of malocclusion prevalence, it lacked demographic variables such as age, which may help identify high-risk groups and improve targeted preventive strategies in future research.

This study emphasizes the need to implement region-specific orthodontic care programs to address the identified prevalence rates. The findings highlight the importance of early detection and timely intervention in managing malocclusion and provide a foundation for future research and preventive strategies. It is recommended that primary healthcare centers adopt a standardized early orthodontic assessment framework to guide general dentists in identifying malocclusion at an earlier stage. This framework should include simplified screening criteria based on the Index of Orthodontic Treatment Need to distinguish mild cases from those requiring early referral.

The prevalence of malocclusion observed in this study may be partially explained by delayed care-seeking behavior among patients. Applying the Health Belief Model (HBM) provides a useful framework for understanding this phenomenon, as many patients or their parents may have low perceived susceptibility to severe malocclusion or underestimate its severity, and perceived barriers such as cost, time, or fear of dental procedures may further delay seeking care. Enhancing awareness through educational interventions targeting these HBM constructs could promote earlier dental visits, reduce treatment complexity, and prevent progression to cases requiring surgical orthodontic treatment.[35]

From a public health perspective, integrating routine oral health screening into primary healthcare, promoting school-based oral health education, encouraging healthy dietary habits, and developing community-level preventive programs can help reduce the prevalence of malocclusion. Policymakers should consider evidence-based guidelines for standardized assessment and early management of dental anomalies to ensure equitable access to care, enhance oral health outcomes, and lower long-term healthcare costs associated with complex orthodontic treatments.

Conclusions

This study found that, while the majority of patients had adequate occlusion, a notable proportion presented with dental anomalies that may complicate treatment planning. These findings emphasize the importance of early diagnosis and orthodontic screening, particularly in university clinic settings. Incorporating dental anomaly monitoring into national oral health initiatives, with a focus on pediatric populations, may help reduce the prevalence of malocclusion and improve long-term functional and aesthetic outcomes. Further multicenter studies with broader demographic data are recommended to enhance generalizability and guide evidence-based public health policies for preventive orthodontic care.

Authors Contributions

RB and RFA: conceived and designed the study, conducted research, provided research materials. RA collected and organized data ‘analyzed and interpreted data, wrote initial and final draft of article. RB Writing and revising the manuscript and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Funding

This research received no external funding.

Data Availability Statement

“Not applicable”.

Acknowledgments

We would like to acknowledge the invaluable contributions of Dr. Rabia Bilal to this research. Her guidance and expertise were deeply appreciated and continue to inspire us. We also would like to express our sincere appreciation to Dr. Ahmed Al Fawzan for his kind assistance and valuable guidance throughout this work.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Slaghour MA, Bakhsh AK, Hadi IH, Jably RM, Alqahtani MS, Alqahtani AA, *et al*. Dental occlusion and malocclusion: Prevalence, types and treatment. EC Dent Sci 2019;18:1776-83.
2. Asiry MA, Alshahrani I. Prevalence of malocclusion among school children of Southern Saudi Arabia. J Orthod Sci 2019;8:2.
3. Mohammad BH, Abdul-Jabbar MF, Mohammed MH. Prevalence of angle’s classification of malocclusion among patients attending orthodontic department in college of dentistry-retrospective cross-sectional study. Erbil Dent J 2022;4:111-7.
4. Zakirulla M. Malocclusion in deciduous dentition of Saudi children: A cross-sectional study. Bangladesh J Med Sci 2012;11:343-6.
5. Aldhorae KA, Altawili ZM, Assiry A, Alqadasi B, Al-Jawfi KA,

Hwaiti H. Prevalence and distribution of dental anomalies among a sample of orthodontic and non-orthodontic patients: A retrospective study. J Int Oral Health 2019;11:309-17.
6. Molina-Solana R, Solano-Reina E, Yáñez-Vico RM. Malocclusion and prevalence of developmental dental anomalies of form, size, number and eruption in Southern Europe. J Stomatol 2017;70:24-30.
7. Hassan R, Rahimah AK. Occlusion, malocclusion and method of measurements-an overview. Arch Orofac Sci 2007;2:3-9.
8. Nainani JT, Relan S. Prevalence of malocclusion in school children of Nagpur rural region-an epidemiological study. J Indian Dent Assoc 2011;5:865-7.
9. Rubika J, Felicita AS, Sivambiga V. Gonial angle as an indicator for the prediction of growth pattern. World J Dent 2015;6:161-3.
10. Baral P. Prevalence of malocclusion in western Nepal. Orthod J Nepal 2015;5:6-8.
11. Proffit WR, Fields HW Jr., Sarver DM. Contemporary Orthodontics. Netherlands: Elsevier Health Sciences; 2006.
12. Almotairy N, Almutairi F. A nation-wide prevalence of malocclusion traits in Saudi Arabia: A systematic review. J Int Soc Prev Community Dent 2022;12:1-11.
13. Angle EH. Malocclusion of the Teeth. Philadelphia, PA: White Manufacturing Co.; 1907.
14. Durgesh BH, Prakash P, Ramakrishnaiah R, Subashchandra Phulari B, Al Kheraif AA. Malocclusion pattern (Angle's) in mauritian orthodontic patients. ISRN Dent 2012;2012:210306.
15. Madiraju GS, Almugla YM, Mohan R, Alnasser BM. An epidemiological study on early orthodontic treatment need among eastern Saudi Arabian children in the mixed dentition stage. Sci Rep 2024;14:4084.
16. Rosenblum RE. Class II malocclusion: Mandibular retrusion or maxillary protrusion? Angle Orthod 1995;65:49-62.
17. Alyami D, Alharbi A, Hatan Y, Asiri YM, Alharthy H, Alogaibi YA. Prevalence of malocclusion and orthodontic treatment needs among adolescents in Najran City, Saudi Arabia. J Orthod Sci 2023;12:60.
18. Gudipaneni RK, Aldahmeshi RF, Patil SR, Alam MK. The prevalence of malocclusion and the need for orthodontic treatment among adolescents in the northern border region of Saudi Arabia: An epidemiological study. BMC Oral Health 2018;18:16.
19. Alharbi F. The prevalence of malocclusion traits in Saudi Arabia 2015-2019: An epidemiological cross sectional study. J Int Oral Health 2020;12:129-34.
20. Selmani M, Bukleta MS. Prevalence of dental anomalies in various categories of malocclusion among orthodontic patients in the Kosovo Region: A retrospective study. Eur J Gen Dent 2023;12:103-8.
21. Agarwal A, Reddy VK, Das M, Khan M, Todkar M. Prevalence of malocclusion and its relationship with sociodemographic factors, dental caries and oral hygiene status in 12-15 years children of Lucknow City. J Clin Diagn Res 2021;15:52-6.
22. Khan SQ, Ashraf B, Khan AQ, Mehdi H. Prevalence of malocclusion and its relation with crowding and spacing. Pak Oral Dent J 2014;34:472-6.
23. Lin M, Xie C, Yang H, Wu C, Ren A. Prevalence of malocclusion in Chinese schoolchildren from 1991 to 2018: A systematic review and meta-analysis. Int J Paediatr Dent 2020;30:144-55.
24. Sayin MÖ, Türkkahraman H. Malocclusion and crowding in an orthodontically referred Turkish population. Angle Orthod 2004;74:635-9.
25. Shahzad S, Alam J, Ashfaq M. An analysis of orthodontic patients treated during 2001 at Khyber college of dentistry, Peshawar. Pak Oral Dent J 2002;22:149-50.
26. Onyeaso CO. Prevalence of malocclusion among adolescents in Ibadan, Nigeria. Am J Orthod Dentofacial Orthop 2004;126:604-7.
27. El-Mangoury NH, Mostafa YA. Epidemiologic panorama of dental occlusion. Angle Orthod 1990;60:207-14.
28. Asiry MA. Occlusal status among 12-16 year-old school children in Riyadh, Saudi Arabia. J Int Oral Health 2015;7:20-3.
29. Abu Alhaija ES, Al-Khateeb SN, Al-Nimri KS. Prevalence of malocclusion in 13-15 year-old North Jordanian school children. Community Dent Health 2005;22:266-71.
30. Borzabadi-Farahani A, Borzabadi-Farahani A, Eslamipour F. Malocclusion and occlusal traits in an urban Iranian population. An epidemiological study of 11- to 14-year-old children. Eur J Orthod 2009;31:477-84.
31. Sheloni M, Nadeem MA, Adil Ahmed MA, Anu V. Dental anomalies among patients with malocclusion-a cross sectional study. J Dent Med Sci 2016;15:33-7.
32. Giffoni TC, Brandt GZ, Rocha IS, Ramos AL, Provenzano MG, Fracasso M. Relation of dental anomalies with occlusal alterations in the pediatric patients. Pesqui Bras Em Odontopediatr Clín Integr 2019;19:e4026.
33. Al-Jabaa AH, Aldrees AM. Prevalence of dental anomalies in Saudi orthodontic patients. J Contemp Dent Pract 2013;14:724-30.
34. Thilander B, Pena L, Infante C, Parada SS, De Mayorga C. Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. Eur J Orthod 2001;23:153-67.
35. Shubayr MA. Integration of health behaviour theories in dentistry: A systematic review. Open Dent J 2025;19:1-14.