

Prevalence of Anteroposterior facial lateral profile pattern and orthodontic malocclusions for Libyan schoolchildren in Tarhuna city: an epidemiological study

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معدل انتشار نمط المظهر الجانبي للوجه (الأمامي-الخلفي) وسوء الإطباق التقويمي لدى تلاميذ
المدارس الليبيين في مدينة ترهونة (دراسة وبائية)

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Abstract:

Background: Malocclusion represents a significant public health concern among pediatric populations, leading to potential functional, aesthetic, and psychosocial implications. Assessing local prevalence patterns is essential to inform targeted preventive strategies and early interceptive interventions **Objectives:** To determine the prevalence of anteroposterior facial lateral profile patterns and orthodontic malocclusions among primary schoolchildren in Tarhuna city, Libya. **Materials and Methods:** A cross-sectional epidemiological study was conducted on 1,310 schoolchildren (640 males, 670 females) across 8 primary schools in Tarhuna during the 2025–2026 academic year. Standardized clinical examinations recorded extra-oral profile patterns, intra-oral molar/canine/incisor classifications, overjet, overbite, open bite, and crossbite occurrences. Data were evaluated using SPSS (v26.0) with Chi-square tests ($p < 0.05$) **Results:** A distinct gender divergence was identified ($p < 0.001$). The male cohort exhibited a 100.0% normative baseline of Class I straight profiles and Angle Class I molar neutroclusions. Conversely, the female cohort presented significant malocclusion rates: Angle Class II (34.3%) and Class III (15.3%) molar relationships, Class II Division 1 incisor relationships (41.0%), deep bites (18.4%), and cumulative crossbites (17.2%). **Conclusion:** Schoolchildren in Tarhuna display a striking gender-linked variance in malocclusion

prevalence, highlighting the necessity for early school-based screening and timely interceptive orthodontic care during mixed dentition.

Keywords: Facial Lateral, Epidemiological, Schoolchildren.

المخلص

الخلفية: يُعد سوء الإطباق (Malocclusion) مصدر قلق كبير للصحة العامة بين فئة الأطفال، إذ تترتب عليه تداعيات وظيفية وجمالية ونفسية واجتماعية محتملة. لذا، فإن تقييم أنماط الانتشار المحلي يُعد أمراً جوهرياً لتوجيه استراتيجيات الوقاية المحددة والتدخلات التقويمية المبكرة. **الأهداف:** تحديد معدلات انتشار أنماط المظهر الجانبي للوجه (في البعد الأمامي-الخلفي) وحالات سوء الإطباق التقويمي بين تلاميذ المدارس الابتدائية في مدينة ترهونة، ليبيا. **المواد والطرق:** أجريت دراسة وبائية مقطعية شملت 1310 تلاميذ (640 ذكراً و 670 أنثى) في 8 مدارس ابتدائية بمدينة ترهونة خلال العام الدراسي 2025-2026. تضمنت الدراسة فحوصات سريرية معيارية لتسجيل أنماط المظهر الجانبي الخارجي للوجه، وتصنيفات الإطباق داخل الفم (للأضراس والأنياب والقواطع)، وحالات البروز الأمامي (overjet)، والتراكب العمودي (overbite)، والعضة المفتوحة (open bite)، والعضة المعكوسة (crossbite). تم تحليل البيانات باستخدام برنامج SPSS (الإصدار 26.0) واختبار مربع كاي (Chi-square) عند مستوى دلالة ($p < 0.05$). **النتائج:** لوحظ تباين واضح بين الجنسين ($p < 0.001$). فقد أظهرت مجموعة الذكور نمطاً طبيعياً بنسبة 100% تمثل في المظهر الجانبي المستقيم (Class I profile) وعلاقة الأضراس من النوع الأول (Angle Class I neutroclusion). وفي المقابل، سجلت مجموعة الإناث معدلات ملحوظة لسوء الإطباق، شملت: علاقات الأضراس من النوع الثاني (34.3%) والنوع الثالث (15.3%) وفق تصنيف "أنغل" (Angle)، وعلاقات القواطع من النوع الثاني - القسم الأول (41.0%)، والعضة العميقة (18.4%)، والعضة المعكوسة (17.2%). **الخلاصة:** يُظهر تلاميذ المدارس في ترهونة تبايناً لافتاً مرتبطاً بالجنس في معدلات انتشار سوء الإطباق، مما يؤكد ضرورة إجراء فحوصات مسحية مبكرة في المدارس وتوفير رعاية تقويمية تدخلية في الوقت المناسب خلال مرحلة بزوغ الأسنان المختلطة (mixed dentition).

الكلمات المفتاحية: الجانب الوجهي، وبائي، تلاميذ المدارس.

Introduction

Oral health in children is a vital component of general health and overall well-being ⁽¹⁾, as it plays a vital role in essential functions such as mastication, speech, and social interaction ⁽²⁾. Maintaining good oral health and no bad oral habits during childhood period is crucial for proper growth and development ⁽³⁾, as well as for preventing long-term complication that may affect both physical and psychological state ⁽⁴⁾.

Malocclusion is one of the most common oral health problems among children ⁽⁵⁾. It is defined as a disorder in the alignment of teeth and jaws that results in functional and aesthetic imbalance within the oral cavity ⁽⁶⁾. Malocclusion can negatively affect mastication, speech, and facial appearance ⁽⁷⁾, and may also impact the child's psychological status and quality of life ⁽⁸⁾. Assessing its prevalence is essential to determine the need for early intervention and to prevent future complications ⁽⁹⁾.

Globally, malocclusion represents a significant public health concern ⁽¹⁰⁾, with varying prevalence rates reported across different populations due to genetic, environmental, and behavioral factors ⁽¹¹⁾. Several factors are associated with the development of malocclusion ⁽¹²⁾. General health conditions, including chronic diseases, disabilities, and previous orthodontic

treatment⁽¹³⁾, may influence occlusal development and increase the likelihood of dental and skeletal irregularities⁽¹⁴⁾. In addition, oral habits such as thumb-sucking, tongue thrust, and persistent mouth breathing play a significant role in altering jaw growth and tooth alignment⁽¹⁵⁾. Anatomical factors, including tongue size, jaw size, and mandibular shifts⁽¹⁶⁾, also contribute to occlusal discrepancies and improper distribution of occlusal forces⁽¹⁷⁾.

The evaluation of malocclusion is based on both facial and dental characteristics⁽¹⁸⁾. This includes the assessment of facial profile, molar, incisor, and canine classification, overjet, and bite type⁽¹⁹⁾.

Malocclusion is commonly classified according to Angle's classification into Class I, Class II, and Class III⁽²⁰⁾, providing a standardized approach for diagnosis and treatment planning⁽²¹⁾.

Dental caries is another important factor that may influence occlusal development⁽²²⁾. Poor dental health and untreated caries can lead to early tooth loss⁽²³⁾, shifting of adjacent teeth, and disruption of normal occlusion⁽²⁴⁾ thereby increasing the complexity of malocclusion and negatively affecting overall oral function⁽²⁵⁾.

Epidemiological studies are essential for defining the distribution of malocclusion and its associated determinants⁽²⁶⁾, which in turn support the development of effective preventive and therapeutic strategies⁽²⁷⁾.

The aim of this study is to determine the prevalence of facial profile patterns and orthodontic malocclusions among schoolchildren in Tarhuna City.

Materials and Methods

A cross-sectional epidemiological study was conducted to evaluate the prevalence of facial profile patterns and orthodontic malocclusions among schoolchildren in Tarhuna city, Libya, during the school year 2025–2026. A total of 1,310 school-aged children were included across 8 targeted primary and basic schools in the city. The participant cohort comprised a total of 640 males and 670 females.

Data were collected using a structured clinical examination proforma combined with a questionnaire designed to gather demographic details, medical history (recording whether the patient has any chronic medical conditions, disabilities, or previous dental/orthodontic treatments).

Participants were included if they had fully erupted first permanent molars and incisors. Conversely, children were excluded from the study if they had a history of previous orthodontic treatment with removable appliances, major craniofacial anomalies, documented physical or mental disabilities, missing essential teeth, or incomplete questionnaire/examination data.

Clinical examinations were performed by trained examiners while the patient was comfortably seated in an upright position with the head in a natural head position (parallel to the floor and vertically upright). Standard sterile mouth mirrors and dental probes were used to record the clinical parameters, which included:

Extra-oral assessment: Lateral facial profile patterns



(figure 1)



(figure2)

Intra-oral assessment: Molar, canine, and incisor relationships, along with overjet measurements and bite types. Data processing and statistical evaluation were executed using SPSS software (Version 26.0), calculating absolute frequencies, percentages, and applying the Pearson Chi-square test with significance established at $p < 0.05$.

Results

Almost all assessed craniofacial morphology and dental parameters showed a highly significant gender-based polarization, according to the assembled clinical data ($p < 0.001$). Table 1 shows that 100% of the male cohort had an Angle Class I molar connection and a normal/straight sagittal facial lateral profile (Class I). On the other hand, skeletal profile deviations and molar relationship discrepancies were highly concentrated in the female cohort; skeletal Class II was present in 3.0% and 5.1% of female schoolchildren, respectively (convex) and Class III (concave) profiles, respectively. Furthermore, Angle Class II molar relations (combined 1/2 and full unit) affected 34.3% of the female group, while Class III molar configurations (combined 1/2 and full unit) were diagnosed in 15.3% of the females (Table 1). Regarding the anterior dentition traits summarized in Table 2, the vast majority of males (98.3%) maintained a normal incisor relationship, though minor sagittal variations were captured, with 1.6% exhibiting a Class II Division 1 configuration and 0.2% showing a Class II Division 2 pattern. Conversely, only 27.0% of female subjects displayed a normal incisor relation; a Class II Division 1 relationship emerged as the most dominant anomaly in this group, affecting 41.0% of the female sample, followed by a Class III incisor relationship at 21.9%. Horizontal dental arch discrepancies mirrored this pattern of female predominance ($p < 0.001$). Abnormal horizontal discrepancies, specifically large overjets (33.4%) and negative overjets (24.5%), affected more than half of the examined female children, while remaining entirely absent (0.0%) among the male cohort (Table 2). Finally, the clinical assessment of vertical and transverse bite types (Table 3) demonstrated that while all male children (100.0%) maintained a normal physiological occlusion, the female cohort carried a substantial structural therapeutic burden ($p < 0.001$). Among the female schoolchildren, a normal bite type was verified in less than half of the sample (40.6%). Deep bite was diagnosed in 18.4% of the female population, followed closely by an edge-to-edge relationship at 14.5%, and an open bite configuration at 9.4%. Transverse abnormalities were also prominent in females, with an anterior crossbite recorded in 8.0%, a unilateral posterior crossbite in 8.0%, and a bilateral posterior crossbite affecting 1.2% of the group.

Table 1: Prevalence of Facial Lateral Profile and Angle Molar Classification by Gender

Orthodontic Parameter	Total Sample (N=1267)	Male Cohort (n=639)	Female Cohort (n=628)	pvalue
Anteroposterior Profile				0.001>
Class I (Straight) -	%96.0	%100.0	%91.9	
Class II (Convex) -	%1.5	%0.0	%3.0	
Class - III (Concave)	%2.5	%0.0	%5.1	
Angle *Molar Relation	(N=1206)	(n=639)	(n=567)	0.001>
Class I -	%76.7	%100.0	%50.4	
Class II 1/2 Unit -	%13.8	%0.0	%29.5	
Class II Full Unit -	%2.2	%0.0	%4.8	
Class III 1/2 Unit -	%5.2	%0.0	%11.1	
Class III Full Unit -	%2.0	%0.0	%4.2	

Note: Molar classification evaluated based on the valid cases within (the Angle Class sub-dataset (N=1206)).

Table 2: Prevalence of Incisor Anomalies and Dental Arch Discrepancies

Occlusal Variable	Total Sample (%)	Male Cohort (n=639)	Female Cohort (n=634)	p value
Incisor Classification (N=1273)				0.001>
Class I (Normal) -	%62.8	%98.3	%27.0	
Class II Division 1 -	%21.2	%1.6	%41.0	
Class II Division 2 -	%5.1	%0.2	%10.1	
Class III -	%10.9	%0.0	%21.9	

Overjet Distribution (N=1283)			(n=644)	0.001>
Normal -	%70.9	%100.0	%42.1	
Large -	%16.8	%0.0	%33.4	
Negative -	%12.3	%0.0	%24.5	

Table 3: Distribution of Vertical and Transverse Bite Types Stratified by Gender

Bite Type Parameter	Total Sample (N=1280)	Male Cohort (n=639)	Female Cohort (n=641)	pvalue
Bite Type Anomalies				0.001>
Normal -	%70.2	%100.0	%40.6	
Deep Bite -	%9.2	%0.0	%18.4	
Edge to Edge -	%7.3	%0.0	%14.5	
Open Bite -	%4.7	%0.0	%9.4	

- Anterior Crossbite	%4.0	%0.0	%8.0	
Unilateral-Posterior Crossbite	%4.0	%0.0	%8.0	
Bilateral - Posterior Crossbite	%0.6	%0.0	%1.2	

Table 4: Demographic Distribution of the Screened Schoolchildren Cohort Across the Selected Educational Institutions (N=1321)

Selected Screening School	Frequency (n)	Percentage (%)	Valid Percentage (%)	Cumulative (%) Percentage
Abu Bakr Al Siddiq	170	%12.9	%12.9	%12.9
Al-Salam	147	%11.1	%11.1	%24.0
Ruwad Al-Ilm	182	%13.8	%13.8	%37.8
Al-Sayeh Abu Kulish	160	%12.1	%12.1	%49.9
Shuhada Tarhuna	172	%13.0	%13.0	%62.9
Salah Al-Din	331	%25.1	%25.1	%88.0
Kun Faridan	76	%5.8	%5.8	%93.7
Masarat Al Ma'rifah	83	%6.3	%6.3	%100.0
Total Sample Size	1321	%100.0	%100.0	—

The total sample size recruited for this epidemiological survey comprised 1,321 school children primary cluster-selected from eight geographically diverse public and private schools within Tarhuna municipality, ensuring a thoroughly representative cross-section of the local pediatric population.

As structured in Table 4, the proportional frequency distribution across the targeted schools was led by Salah Al-Din school, which accounted for the largest segment with 331 students (25.1%), followed by Ruwad Al-Ilm (n=182, 13.8%), Shuhada Tarhuna (n=172, 13.0%), and Abu Bakr AlSiddiq (n=170, 12.9%).

The remaining screening cluster samples were balanced among Al-Sayeh Abu Kulish (12.1%), Al-Salam (11.1%), Masarat Al-Ma'rifah (6.3%), and Kun Faridan (5.8%). To capture a holistic baseline reflecting both the mixed dentition stage and early permanent dentition development, the clinical inclusion parameters isolated: Healthy, unselected school children within the physiological chronological age range of 6 to 14 years. Subjects with no ongoing history or clinical evidence of interceptive or comprehensive fixed/removable orthodontic appliances. Children with an absence of evident craniofacial syndromes, structural skeletal anomalies (e.g., cleft lip and palate), or recent history of localized major orofacial dental trauma."

Study Population and Descriptive Demographics

The primary epidemiological cohort recruited for this school-based survey initially comprised a total cluster sample of 1,321 children within Tarhuna city, Libya. Following data auditing, clinical records were processed through frequency distribution parameters to outline the true baseline characteristics of the examined society. As detailed in Table 5, gender stratification within the valid responding sample (N=1,310; with 11 systemic missing entries) demonstrated a highly balanced distribution, consisting of 640 males (48.9%) and 670 females (51.1%). The chronological age distribution was structuralized into four distinct growth development periods based on valid clinical entries (N=1,269; 52 missing entries). The predominant demographic segment was captured within the 11–13 years age category, representing 680 subjects (53.6%), followed by the 8–10 years group with 369 subjects (29.1%). The early permanent and late adolescent group (14–16 years) accounted for 106 children (8.4%), while the early mixed dentition stage (5–7 years) comprised 114 children (9.0%).

Clinical Baseline Eligibility and Health Status

In alignment with the structural selection criteria designed to evaluate natural occlusal baselines, specific screening filters were tracked: Chronic Medical Conditions: The vast majority of the valid sample (1,222 children; 93.3%) was completely healthy. However, 88 children (6.7%) presented with controlled chronic medical conditions, which were documented without affecting their inclusion in the general epidemiological macro-assessment. Prior Removable Orthodontic Therapy: Clinical screening identified only one single case (0.1%) with a history of interceptive treatment involving a removable orthodontic appliance, whereas 1,308 children (99.9%) were completely naive to orthodontic intervention. This single active case was excluded from the final dental relationship correlations to eliminate artificial skewing of the baseline malocclusion data. Disabilities: Physical or developmental disabilities were structurally rare in the screened population, affecting only 2 subjects (0.2%) out of 1,309 valid cases, while 1,307 children (99.8%) presented with no clinical disabilities

Table 5: Comprehensive Descriptive Baseline and Clinical Characteristics of the Tarhuna Schoolchildren Sample (N=1321)

Demographic Clinical Parameter	Frequency (n)	Valid) Percentage (%)	Cumulative (%) Percentage	System Missing (n)
Gender Stratification				11
Male -	640	%48.9	%48.9	
Female -	670	51.1 %	100.0 %	
Chronological Age Groups				52
Years 7–5 -	114	%9.0	%9.0	
Years 10–8 -	369	%29.1	%38.1	
Years 13–11 -	680	%53.6	%91.6	
Years 16–14 -	106	8.4 %	100.0 %	
Chronic Medical Conditions				11
Yes -	88	%6.7	%6.7	
No -	1222	93.3 %	100.0 %	
Previous Removable Orthodontic Appliance				12
Yes -	1	%0.1	%0.1	

No -	1308	99.9 %	100.0 %	
Presence of Disabilities				12
Yes -	2	%0.2	%0.2	
No -	1307	%99.8	%100.0	

Note: Valid percentages are calculated based on the total responding cases within each individual variable sub-dataset, excluding missing system entries to maintain statistical precision.

Table 6: Prevalence of Anteroposterior Facial Lateral Profile and Angle Molar Classification Stratified by Gender

Orthodontic Parameter	Total Sample (%)	Male Cohort (%) (n=639)	Female Cohort (%) (n=628)	p-value
Anteroposterior Profile (N=1267)				{*}^0.001>
Class I (Straight) -	%96.0	%100.0	%91.9	
Class II (Convex) -	%1.5	%0.0	%3.0	
Class III (Concave) -	%2.5	%0.0	%5.1	
Angle Molar Relation (N=1206)			(n=567)	{*}^0.001>
Class I (Normal) -	%76.7	%100.0	%50.4	
Class II 1/2 Unit -	%13.8	%0.0	%29.5	
Class II Full Unit -	%2.2	%0.0	%4.8	
Class III 1/2 Unit -	%5.2	%0.0	%11.1	
Class III Full Unit -	%2.0	%0.0	%4.2	

Denotes highly significant statistical differences ($p < 0.001$) calculated via Pearson Chi-Square test.

The distribution of anterior dental arch traits and vertical/transverse discrepancies further confirmed the heavy clustering of orthodontic pathologies within the female school population ($p < 0.001$). As summarized in Table 7: Incisor Relationship: Although the vast majority of males (98.3%) maintained a normal incisor relationship, minor sagittal variations were captured within the male sample, with 1.6% exhibiting a Class II Division 1 configuration and 0.2% showing a Class II Division 2 pattern (N=1273). Conversely, only 27.0% of female subjects displayed a normal incisor relation. A Class II Division 1 relationship emerged as the heavily dominant anterior anomaly among females, affecting 41.0% of the subgroup, followed by a Class III incisor relationship at 21.9%. Bite Type Anomalies: Vertical and transverse malocclusion traits (N=1280) were restricted exclusively to female children. Less than half of the female cohort (40.6%) presented with a normal clinical bite type. Among the diagnosed vertical anomalies in females, deep bite affected 18.4% of the population, followed by an edge-to-edge relationship at 14.5%, and an anterior open bite configuration at 9.4%. Transverse discrepancies were also highly prominent in females, with an anterior crossbite recorded in 8.0%, a unilateral posterior crossbite in 8.0%, and a bilateral posterior crossbite affecting

1.2\% of the group. In sharp contrast, the male schoolchildren consistently maintained a 100.0\% ideal baseline with zero vertical or transverse occlusal deviations.

Table 7: Prevalence of Incisor Anomalies and Vertical/Transverse Bite Types by Gender

Occlusal Variable Trait	Total Sample (%)	Male Cohort (%) (n=639)	Female Cohort (%) (n=634)	p-value
Incisor Classification (N=1273)				{*}^0.001>
Class I (Normal) -	%62.8	%98.3	%27.0	
Class II Division 1 -	%21.2	%1.6	%41.0	
Class II Division 2 -	%5.1	%0.2	%10.1	
Class III -	%10.9	%0.0	%21.9	
Bite Type Distribution (N=1280)			(n=641)	{*}^0.001>
Normal Bite -	%70.2	%100.0	%40.6	
Deep Bite -	%9.2	%0.0	%18.4	
Edge to Edge -	%7.3	%0.0	%14.5	
Open Bite -	%4.7	%0.0	%9.4	
Anterior Crossbite -	%4.0	%0.0	%8.0	
Unilateral Posterior Crossbite	%4.0	%0.0	%8.0	
Bilateral Posterior - Crossbite	%0.6	%0.0	%1.2	

Denotes highly significant statistical differences ($p < 0.001$) calculated via Pearson Chi-Square test.

Results Overview of Gender Polarization and Statistical Significance

The compiled clinical data revealed a profound gender-based polarization across nearly all evaluated craniofacial morphological patterns and dental occlusal parameters within the examined school population of Tarhuna city. Bivariate inferential analysis using the Pearson Chi-square (X^2) test demonstrated a highly significant statistical association between gender and the distribution of orthodontic traits ($p < 0.001$). These findings empirically underscore that the baseline orthodontic and structural phenotypes of this population are deeply divergent by sex, exhibiting a sharp morphological demarcation between the male and female subsets.

Craniofacial Profiles and Molar Discrepancies

As summarized in Table 6, the male cohort displayed a highly uniform and ideal normative baseline. One hundred percent (100.0\%) of the examined male individuals presented with an exclusively straight anteroposterior facial lateral profile (Class I) and a physiological neutroclusion characterized by an Angle Class I molar relationship. Conversely, the female cohort carried the overwhelming clinical burden of sagittal skeletal and molar relationship discrepancies ($p < 0.001$).

Within the female subgroup, structural deviations from the ideal straight profile were captured, with 3.0\% exhibiting a Class II (convex) facial lateral profile pattern and 5.1\% presenting with

a Class III (concave) skeletal configuration (N=1267). Furthermore, sagittal molar malocclusions presented a major structural therapeutic weight in females: Angle Class II molar relations (combined 1/2 and full unit deviations) affected 34.3% of the female sample, while Class III molar configurations (combined 1/2 and full unit deviations) were diagnosed in 15.3% of this group, whereas the male cohort displayed zero baseline variance (0.0% molar anomalies).

Incisor Anomalies and Vertical/Transverse Bite Variations

The distribution of specific anterior dental arch traits and vertical/transverse discrepancies further confirmed the heavy clustering of orthodontic pathologies within the female school population ($p < 0.001$). Bivariate tracking of the anterior segment (Table 7) revealed that while the vast majority of males (98.3%) maintained a normal incisor relationship, minor sagittal variations were captured within the male sample, with Class II Division 1 affecting 1.6% and Class II Division 2 affecting 0.2% of the male individuals (N=1273).

Within the female cohort, a normal physiological incisor relationship was verified in only 27.0%, with Class II Division 1 emerging as the heavily dominant anterior anomaly at 41.0%, followed by a Class III incisor relationship at 21.9%.

Furthermore, vertical and transverse bite variations followed a similar pattern of female predominance and absolute restriction ($p < 0.001$). Among females (N=1280), a normal vertical bite was recorded in less than half of the sample (40.6%). Deep vertical bite affected 18.4% of the female cohort, edge-to-edge configurations were observed in 14.5%, and an anterior open bite was recorded in 9.4%. Additionally, transverse discrepancies—encompassing anterior crossbite (8.0%), unilateral posterior crossbite (8.0%), and bilateral posterior crossbite (1.2%)—cumulatively affected 17.2% of the female cohort. In sharp contrast, the male children consistently maintained a 100.0% ideal baseline configuration across all evaluated vertical and transverse parameters.

Discussion The Phenomenon of Near-Absolute Craniofacial Gender Polarization

The most compelling and clinically striking finding derived from this population-based epidemiological survey conducted within the public school population of Tarhuna city is the near-absolute segregation of orthodontic and craniofacial traits based on gender. While the male cohort demonstrated a remarkably uniform, normative baseline—presenting with a highly homogenous distribution of ideal Class I straight facial profiles, Class I molar neutroclusion, and normal vertical/transverse bite types—the female cohort bore the vast majority of the clinical burden of craniofacial and dental discrepancies identified within the sampled population. Notably, the high-resolution data disproved a complete, absolute absence of anomalies in males, as minor anterior dentition discrepancies were captured, with Class II Division 1 appearing in 1.6% of the male sample.

However, this minor architectural deviation remains epidemiologically negligible compared to the female subgroup, where a Class II Division 1 incisor malocclusion emerged as the heavily dominant sagittal anomaly, affecting 41.0% of this group.

This high prevalence of sagittal discrepancy within the female cohort was intrinsically linked to pronounced vertical and transverse occlusal deviations, including an increased vertical overbite (deep bite) at 18.4%, an edge-to-edge relationship at 14.5%, and an anterior open bite configuration at 9.4%, alongside notable clinical presentations of crossbites (Table 7).

Comparison with Regional and International Literature

This extreme phenotypic dimorphism stands in sharp contrast to a vast body of regional and international literature. Classic epidemiological studies across various European, Asian, and Latin American populations typically report minor, statistically non-significant variations between genders regarding primary occlusion types, molar classifications, and softtissue facial

profiles. Where gender differences are reported internationally, they rarely present as an all-or-nothing distribution; rather, they reflect minor variations in percentage distribution or vertical dimensions associated with gender-linked skeletal maturation timing.

The intense clustering of virtually all profile deviations, severe molar discrepancies, horizontal overjet anomalies, and vertical/transverse bite anomalies almost exclusively within the female cohort in Tarhuna presents a unique epidemiological layout that challenges conventional dental literature.

Morphogenetic, Epigenetic, and Public Health Implications

From an etiological perspective, this phenotypic trend strongly implies the influence of isolated localized genetic trends, specific epigenetic components, or highly distinct gender-linked morphogenetic growth patterns unique to this interior region of western Libya. The zero-variance profile among males suggests a highly preserved, conservative genetic baseline governing craniofacial growth, whereas the high anomaly concentration among females points toward a vulnerable morphogenetic pathway susceptible to sagittal and vertical expansion anomalies. Factors such as localized endogamy, historical tribal lineage structures, or genderdistinct functional and non-nutritive habits unique to early childhood in this region must be considered as potential epigenetic triggers driving this polarization.

From a public health perspective, these findings hold substantial practical implications for the regional healthcare infrastructure and oral health strategy in Libya. The complete divergence of treatment needs dictates that public school screening initiatives, clinical personnel deployment, and preventive or interceptive orthodontic workflows in Tarhuna must be fundamentally structured to prioritize the female student demographic, who carry the near-total orthodontic treatment need of the community.

Discussion:

This study reveals a profound gender-based polarization in craniofacial and dental parameters among schoolchildren in Tarhuna city. The male cohort demonstrated a uniform normative baseline, with 100.0% presenting with ideal Class I straight profiles and Angle Class I molar neutroclussions, alongside 98.3% normal incisor relationships and normal vertical/transverse bites. Conversely, the female cohort bore the vast majority of malocclusion burdens. Sagittal skeletal deviations in females included Class II (3.0%) and Class III (5.1%) profiles, while Angle Class II and Class III molar malocclusions affected 34.3% and 15.3% of females, respectively. Normal incisor relationships were observed in only 27.0% of females, with Class II Division 1 emerging as the predominant anomaly at 41.0%, followed by Class III at 21.9%. Furthermore, vertical and transverse discrepancies such as deep bites (18.4%), edge-to-edge relationships (14.5%), open bites (9.4%), and cumulative crossbites (17.2%) were concentrated exclusively within the female group.

When comparing these findings with existing literature, the results demonstrate both notable alignments and distinct divergences with recent global and regional data. On one hand, our findings regarding the high predominance of Class II Division 1 malocclusions and deep bites among school-aged children closely align with the epidemiological findings reported by Al-Omiri and Abu Alhaija ^[14] and regional surveys by Tarhuni and El-Nami ^[15], supporting the concept of heightened susceptibility during the mixed dentition phase. Furthermore, recent craniofacial investigations by Zhou et al. ^[16] corroborate the presence of notable gender-based developmental variances that parallel the higher susceptibility observed in our female cohort. On the other hand, these results sharply diverge from other contemporary investigations. For instance, multi population studies such as those by Al-Bitar et al. ^[17], alongside classical normative parameters outlined by Proffit et al. ^[2], report a more balanced epidemiological spread with minimal or statistically non-significant gender variations in overall malocclusion distribution. This distinct divergence highlights the unique etiological profile of the Tarhuna

population. The striking dimorphism and the severe concentration of anomalies within the female group point toward specific regional, genetic, and environmental drivers such as localized functional habits or differential timing of skeletal maturation thereby reinforcing the necessity for targeted public health interventions and early orthodontic screening tailored specifically to high-risk groups in the region.

Conclusion

1. The survey establishes baseline data demonstrating a striking gender-based polarization in craniofacial morphology and dental malocclusions among Tarhuna schoolchildren.
2. The male population exhibits a uniform normative baseline of ideal Class I profiles, molar neutroclussions, and normal occlusal relationships.
3. The female population carries the near-total therapeutic burden of malocclusions, dominated by Class II Division 1 incisor relationships, deep bites, and crossbite anomalies.
4. Early detection during the mixed dentition stage is critical to facilitate timely interceptive interventions and reduce the severity of developing malocclusions.
5. Further genetic and environmental investigations are warranted to explore the etiologies driving this distinct gender-linked variance.

Recommendations:

Regional healthcare authorities and dental policy planners must implement gender-stratified public health planning, prioritizing interceptive orthodontic programs tailored to the high corrective requirements of female schoolchildren. Routine school-based screening protocols should be established during the mixed dentition stage to enable early diagnosis and timely treatment, thereby minimizing future needs for complex corrective procedures. Furthermore, healthcare authorities should optimize resource allocation to ensure specialized dental services and clinical personnel are effectively directed toward the demographic groups exhibiting the highest clinical treatment need.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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