ORIGINAL RESEARCH

Epidemiology of Facial Profiles, Occlusal Features, and Orthodontic Treatment Need among Adolescence: A Cross-sectional Study

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Abstract

Aims: This study aimed to investigate the incidence and severity of malocclusion and orthodontic treatment needs among randomly selected high school students.

Methods: A multistage stratified random-sampling study was conducted on 1,036 high school students in Sana'a city. The World Dental Federation and World Health Organization method of occlusal traits and the index of orthodontic treatment need were adopted for measurements. Clinically, the molar relationship and facial profile were examined. Assessment of whether examiner or subject perceived the need for orthodontic treatment was made using the esthetic component index. All data were analyzed using the Chi-square test with a significance level of $p < 0.05$.

Results: Normal, convex, and concave facial-profile measurements were found in 81.9, 12.1, and 6.15% of sampled students, respectively. Asymmetrical molar relationship was observed in 16.1% of samples, and most of them were of class I/class II relationships. Increased overjet was noticed in 90.9% of students. Anterior crossbite, deepbite, anterior openbite, posterior openbite, posterior crossbite, and scissor bite accounted for 12.2, 12.8, 3.5, 1.3, 6.6, and 0.6%, respectively. According to the index orthodontic treatment need, 38.9% of students needed some form of orthodontic treatment. Among these cases, 24.3% "definitely" needed treatment, and 59.9% of students needed orthodontic treatment.

Conclusion: Our findings suggested a call for a more conservative treatment approach in dealing with malocclusion problems among high school students in all zones of Sana'a governorate, Yemen.

Clinical significance: A limited number of surveys were performed in Sana'a Governorate to investigate orthodontic treatment needs, facial profiles, and occlusal features among adolescents. The results of this study could guide us to develop a preventive system that minimizes its adverse effects and the need for costly orthodontic treatments.

Keywords: Esthetic component index, Facial profile, Index of treatment need, Malocclusion.

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Introduction

Malocclusion is a normal biological variability from an ideal pattern. Dental malocclusion is defined by the World Health Organization (WHO) as the third-largest oral health problem worldwide related to an individual's general well-being.[1] In fact, it could directly affect psychosocial life, especially that of adolescents.[2] Individuals with malocclusion complain from being considered handicapped in their communities, thereby reflecting negatively on their self-esteem and life quality. At all social levels, well-aligned teeth and a pleasing smile reflect positive status and vice versa.[2] Epidemiological studies performed in Yemen, particularly in Sana'a city, may prompt health policymakers to pay attention to any abnormal deviation from ordinary development in the maxillofacial region. However, not all ethnic groups in the world focus on this issue. Thus, data to formulate a standard guideline are lacking. Available research has indicated differences in malocclusion frequency among ethnic groups, and surprisingly, within the same population.[3–5] Developed countries have advance strategies to promote oral health, whereas developing countries barely exert effort directed into oral health as a quality-of-life determinant. In Yemen, considered one of the poorest developing countries, screening the population for malocclusion prevalence is in progress.

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Two main objectives can be achieved for occlusion assessment. First is to make the people aware of the necessity of specific treatment and second is to increase suggestion for the scheduling of incomes and services for orthodontic therapy. Orthodontists predict the orthodontic problem and its treatment needs by examining dental, facial, occlusal, and skeletal features, in addition to the perception of smile esthetics consistent with treatment needs according to indices.[1,6–8] Later on, studies, databases, and surveys about the incidence of malocclusion was established in the 18th century. However, in the advocacy for this study type in developing countries started later in the 20th century.

In Yemen, which is considered one of the poorest developing countries, the health-system status can explain the inferior orthodontic service. In fact, the frequency and severity of malocclusion play a role in the weak and poor planning for orthodontic services. Hence, the ever-increasing demand for orthodontic treatment need among the Yemeni population should be addressed by using formal assessment tools, such as the index of treatment need (IOTN) and esthetic component (AC) index. The limitations of previous studies need to be covered, and the recommendations that advise the necessity for further studies in the early to late stages of development must be followed.

A database on Yemeni childhood and adulthood has been recently established with relatively few studies.[9,10] Thus, the present study aimed to conduct a survey on facial-profile types and occlusal traits and to determine the normative or interceptive orthodontic or treatment necessity of malocclusion among high school students in Sana'a city, Republic of Yemen. These data can be included in the national database for an adolescent student.

Materials and Methods

Study Design, Sample-size Calculation, and Selection

This cross-sectional study was approved by the medical ethical committee of dental faculty in the University of Science and Technology, Sana'a, Yemen [EAC/UST 125]. Sample collection was performed between September 2019 and March 2020, and the subjects were high school students from different areas of Sana'a city, Yemen. Sample size was calculated with Open Epi software (Version 2.3.1, Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, USA). It revealed the need for a minimum of 384 subjects when considering $p = 5\%$ for 95% confidence level. Schools were selected by simple random sampling to include one private and two public schools. The ratio of private to public schools was 25–75%, and male and female students were included.

Inclusive and Exclusive Criteria

The inclusion criteria were as follows: students with Yemeni nationality, aged between 16 and 18 years, with all permanent teeth erupted (excluding third molars). Students who had large fillings and badly fractured teeth, history of orthodontic treatment, and maxillofacial trauma, evident craniofacial deformities, or congenital anomalies were excluded.

Clinical Examinations and Occlusal Feature Recording

The total number of higher schools' students in Sana'a was 79,438. The examinations were conducted by two examiners, and the students who completed the examination and provided complete demographic data and parental consent to participate in this study were 1,036. At first, consent forms were distributed, and the parents of all participants provided informed consent for their children's participation. Intraoral assessments included occlusal features recommended by the final version of the WHO/FDI basic method for recording malocclusion,[1] which includes alignment of dentition, buccal segment relationship, overjet, overbite, and midline discrepancy. The molar relationship was classified according to Angle's classification[6] to three classes.

Overjet was measured in the subject with central occlusion by using a millimeter-grade caliper. An overjet of more than 4 mm was considered increased, and <2 and 0 mm were taken as edge to edge. The term "reverse overjet" was used if the left and right maxillary incisors were in palatal occlusion. Overbite was measured using Darker et al.'s[11] method when subject was in central occlusion. The amount of openbite was measured directly and recorded to the nearest whole millimeter. Increased overbite was considered when the openbite was >4 mm. Decreased overbite as <1 mm (vertical gap) was considered an openbite. Conversely, posterior openbite recorded only if an overlap of cusps (visible vertical space existed between the teeth when viewed at a right angle to the lateral segment) was absent.[12] Every tooth in the buccal segment was assessed. Crossbite included an anterior and posterior crossbite, and scissor bite was defined according to Baume et al.[12]

The assessment of dental and functional health used by IOTNs[7] is classified into five grades.[8] The AC index comprises a scale of 10 color photographs showing different levels of dental attractiveness, ranging from grade I (representing the most attractive) to grade X (representing the least attractive dentitions).[13] The AC of IOTN in this study was evaluated by two examiners.

All clinical examinations were performed in the schools' clinics by two well-trained examiners by using the same set of instruments (periodontal WHO probes, frontal LED lamp, gloves, masks, cotton, and alcohol) and under the same light conditions. An assistant helped by filling out predesigned forms. The data of each subject were recorded in a standard sheet designed for this study.

After obtaining demographic data, an extraoral assessment (including facial profile) was evaluated in the sagittal plain according to Proffit et al.[14] when a subject was in a natural position. The facial divergence of the line between the forehead and chin was classified into straight, convex, and concave. For AC evaluation, each subject was transferred to a quiet area for self-assessment. The subject assessed his/her mouth with a face mirror and then looked at the AC chart to choose the picture nearest to his/her dental appearance. Table 1 shows the definition of terms used to describe facial features.

Statistical Analysis

All collected data were entered into and digitally analyzed using cross-tabulations with SPSS version 20 (Chicago, Illinois, USA). Data were also analyzed by the Chi-squared test with a significance level set at $p < 0.05$.

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Table 1: Definitions of the occlusal features assessed in this study

Parameter	*Definition*
Occlusal classification[6]	
Class I	The mesiobuccal cusp of the maxillary first permanent molar occludes with the mesiobuccal groove of the mandibular first permanent molar.
Class II	The mandibular molar has shifted distally by half cusp width or more.
Class III	The mandibular molar had shifted mesially by half cusp width or more.
Overjet in mm[6]	A horizontal distance from labial surface of utmost prominent maxillary central incisors to labial surface of mandibular central incisors when teeth are in central occlusion
Overbite[11]	A distance measured from vertical overlap of upper and lower incisors when teeth are in central occlusion.
Openbite[11]	
Anterior	When there was lack of vertical overlap between any of the opposing pairs of incisors, and teeth are in central occlusion
Posterior	Vertical relation of lateral segment by direct inspection of lateral segment of both sides of the mouth with teeth in centric occlusion
Crossbite[13]	
Anterior	When one or more of upper incisors occluded lingual to lower incisors.
Posterior	When buccal cusp of mandibular tooth lay buccal to maximum height of buccal cusp of an opposing maxillary tooth
Scissor bite	When a buccal cusp of a mandibular tooth lies lingual to the maximum height of lingual cusp of an opposing maxillary tooth
IOTN	
Grade I–IV	No need for treatments
Grade V–VII	Borderline need treatments
Grade VIII–X	Greatly need treatments
Facial profile[14]	
Straight	Facial profile when an imaginary line connecting the forehead to the chin is straight
Convex	Facial profile when an imaginary line tilted forward
Concave	Facial profile when an imaginary line tilted backward.

Table 2: Inter- and intraexaminer reliability using the Cohen's Kappa test

Variable	*Interexaminer calibration*	*Intraexaminer calibration*
IONT	0.745	0.788
AC	0.812	0.849
Incisor classification	0.814	0.885
Increased overjet	0.822	0.866
Reverse overjet	0.800	0.735
Anterior crossbite	0.911	0.911
Midline shifting	0.848	0.848
Posterior openbite	0.798	0.798
Anterior openbite	0.862	0.862

Interpretation of Kappa (Kappa 0.0 0.20 0.40 0.60 0.80 1.0) agreement: poor slight fair moderate substantial almost perfect (<0 less than chance agreement, 0.01–0.20 slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, 0.81–0.99 almost perfect agreement)

Results

The overall sample comprised 1,036 students. Among them, 291 (28.1%) were from private schools and 745 (71.9%) were from governmental schools. The percentage of male and female students was 527 (50.9%) and 509 (49.1%), respectively. Inter- and intraexaminer Kappa value ranged from 0.73 to 0.91, which indicated acceptable agreement between the first and second examiners. The results obtained were valid and revealed high interexaminer reliability, ranging from 0.79 to 0.91 (Table 2). The distribution of facial profile among students was 81.8% with a straight profile, 12.1% with convex profile, and 6.1% with a concave profile. The statistical analysis indicated no significant differences between gender for all types of facial profiles $p = 0.07$ (Table 3).

Intraoral assessments included dental discrepancies and occlusal traits to malformed teeth (Ma T; 1.7%), in addition to supernumerary teeth (ST; 0.5%), as shown in Figure 1. Maxillary midline diastema was detected in 6.1% of the students inspected. The analysis presented that the result of diastema prevalence between males and females was 4 and 5%, respectively, which showed no major differences. Therefore, the intergender contrasts were found to have no significant difference, and as observed in dental discrepancies analyzed among gender ($p > 0.05$), the most common dental discrepancies of malformed tooth observed was lateral incisor 1.5% and second premolar 0.2% (Fig. 1). Supernumerary teeth were observed more on the maxilla than on the mandible. Analysis further indicated that three mesiodens and two supplemental maxillary central incisors recorded 0.5% of the total.

Evaluation of occlusal traits involved anteroposterior, transversal, and vertical relationship of both arches together. Crosstabulation of the right- and left-side molar association showed symmetrical molar relationship in 82.2% of students. Symmetrical

Table 3: Distribution of facial-profile types among total sample

Facial profile	*Gender*		*Total*	*p value*
	Male	*Female*		
Straight	426 (80.8%)	422 (82.9%)	848 (81.8%)	0.073
Convex	74 (14.0%)	51 (10.0%)	125 (12.1%)	
Concave	27 (5.1%)	36 (7.1%)	63 (6.1%)	
Class I	366 (69.4%)	386 (72.2%)	734 (70.8%)	0.001***
Class II	61 (11.5%)	47 (9.2%)	108 (10.4%)	
Class III	60 (11.2%)	104 (20.4%)	164 (15.8%)	

***Significance at $p < 0.001$

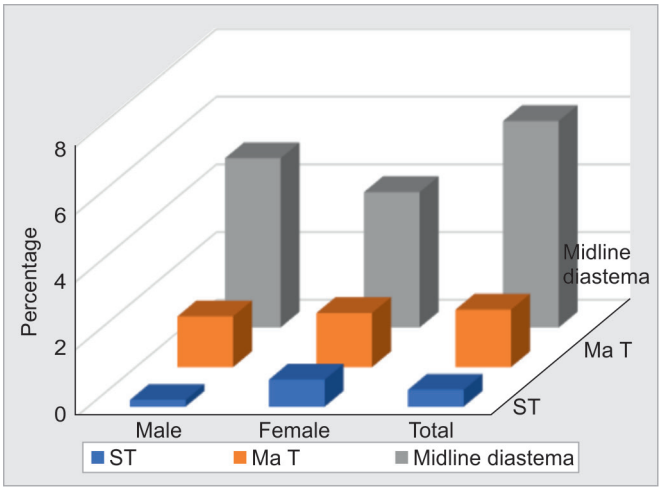

Fig. 1: Distribution of occlusal features between genders

(bilateral) class I was detected in 69% of the participants, whereas bilateral class II and III relationship was registered to be 9% and 4.2% of the school students, respectively. However, asymmetrical molar relationship was documented only in 16.1% of the subject (class I/class II in 8%, class I/class III in 5.6%, and class II/class III in 5.4% of the participants). Molar relationship and gender were found to have significant difference (Table 3).

A larger part of the students 90.9% had normal overjet <5 mm. Maxillary overjet from 5 to 9 mm was 6.3 and 0.8% for more or equal to 9. Conversely, a smaller proportion (5.3%) had reverse overjet. However, the investigation also showed that maxillary overjet was marginally more present in males 6.6% than in females 5.9%, ranging from 5 to 9 mm with increased overjet. The differences in distributed maxillary increased overjet severity by gender were found to have statistically significant difference among genders $p < 0.05$, and no statistically significant difference existed in reverse overjet $p > 0.05$, as shown in Table 4. About 12.2% of the sample showed anterior crossbite. One tooth in crossbite was found to be the most prevalent 3.1%, whereas anterior crossbite including two or three crossbite teeth was present in 2.6% of the influenced subjects. Distribution of anterior crossbite by gender was statistically determined to be nonsignificant $p > 0.05$ between genders (Table 4). We also found that 6.6% of the sample had posterior crossbite, where 3.5% of crossbite recurrence (more than 1 mm but ≥2 mm) was found, which was more than 1.9% of participants in ≤2 mm discrepancy) and 1.2% ≥1 mm. However, analysis among genders was found to have no statistically significant difference $p > 0.05$. Table 4 further shows the prevalence of scissor bite in 0.6% of students, and no significant difference is found by analysis according to gender. At $p > 0.05$, no difference existed between gender. The majority of the subjects 87.2% had satisfactory overbite (2–4 mm overlap), whereas deepbite of 5 to less than 9 mm was found in 10.0%. The incidence of deepbite was 13% among females, which was more than 7.6% among males, whereas prevalence of anterior openbite was noticed in 3.5% of the total samples. The distribution of anterior openbite was 3.6% among males and 3.3% among females, respectively. A statistically significant difference in gender existed ($p < 0.01$; Table 4).

The dental health component of IOTN and findings reflected more orthodontic need among all completely inspected subjects (38.9%), inclusive of grades III, IV, and V. However, those who needed definite treatment were 24.3%, whereas the remaining 14.6% showed "borderline" needs. A statistically significant difference existed among genders $p < 0.05$ (Table 5). Posterior openbite was noticed in 1.3% of students. Findings showed that 1.6% of females had more posterior openbite than 0.9% of males. Moreover, the comparison of posterior openbite by gender had no statistically significant difference ($p > 0.05$), as shown in Table 5. The distribution of orthodontic treatment demands illustrated in Figure 2 was designed according to subjects and gender. The examination showed that females, whose needs for treatment were 55.0%, required more treatment than males 41.0%. A significant difference existed among gender ($p < 0.05$).

Discussion

Dental malocclusion affects many different communities in terms of people's general health, quality of life, and self-esteem. Dental malocclusion may necessitate orthodontic treatment. Orthodontic treatment planning depends on the patient's perception to dentofacial esthetic, the findings of clinical examination, and the skills of the operator.

To our best knowledge, no study has determined the incidence of dental malocclusion, facial profile, assessment of orthodontic treatment need, and AC evaluation among Yemeni young adults. Overall, inter- and intraexaminer reliability values by Kappa test indicated acceptable agreement between the first and second examiners, ranging from 0.79 to 0.91. This finding indicated that the results obtained were in accordance to those of Viera and Garrete.[15]

The prevalence and distribution of facial profiles was 81.8% for straight profiles, 12.1% for convex profiles, and the least frequent, 6.1% for concave profiles. This result was consistent with several studies showing that the most prevalent facial profile type is straight, followed by convex and then concave.[3–5] These populations have different racial origins. The normal or straight facial profile is the predominant type around the world.

Dental discrepancies with selection of supernumerary and crown malformation have been evaluated. In the present study, 0.5% of subjects reported supernumerary teeth. This value was more than that previously reported in a clinical observational study in Yemen (0.4%)[16] and greater that in a radiograph-dependent study (0.99%), which also included impacted supernumerary teeth.[17] The participants had at least one malformed tooth recorded in 1.7%. This value was lower than that of a previous study conducted on Italian school students, which has found a prevalence of 0.9%.[18] The difference may be attributed to the sample size included in the aforementioned study.

A maxillary midline diastema of ≥2 mm in the current study was observed in 9.0% of students, similar to a study conducted on adolescents in Chennai, India.[19] This value is lower than the findings

Table 4: Association of overjet, anterior and posterior crossbite, deepbite and openbite by gender

		Gender			
Parameter		*Male (n = 527)*	*Female (n = 509)*	*Total (1,036)*	*p value*
Maxillary overjet					
None		6 (1.1%)	25 (4.9%)	31 (3.0%)	0.004**
Less than 5 mm		483 (91.7%)	449 (88.2%)	932 (90.0%)	
From 5 to 9 mm		35 (6.6%)	30 (5.9%)	65 (6.3%)	
More or equal to 9 mm		3 (0.6%)	5 (1.0%)	8 (0.8%)	
Reverse overjet		14 (2.7%)	13 (2.6%)	27 (2.6%)	0.918
Type of crossbite details					
Type of anterior crossbite	One tooth	18 (7.4%)	15 (9.6%)	33 (3.18%)	0.632
	Two teeth	10 (1.9%)	9 (1.8%)	19 (1.8%)	
	Three teeth	5 (0.9%)	4 (0.8%)	9 (0.8%)	
Type of posterior crossbite	Less or equal to 1 mm	4 (0.8%)	8 (1.6%)	12 (1.2%)	0.231
	More than 1 mm but less or equal to 2 mm	14 (2.7%)	22 (4.3%)	36 (3.5%)	
	More than 2 mm discrepancy	12 (2.3%)	8 (1.6%)	20 (1.9%)	
	Scissor bite	2 (0.4%)	5 (1.0%)	7 (0.6%)	0.236
Type of bite					
Edge to edge		10 (1.9%)	17 (3.3%)	27 (2.6%)	0.008**
Deepbite of 2–4 mm overlap		477 (90.5%)	426 (83.7%)	903 (87.2%)	
Deepbite of 5 mm to less than 9 mm		40 (7.6%)	64 (12.6%)	104 (10.0%)	
Deepbite of 9 mm or greater		0 (0.0%)	2 (0.4%)	2 (0.2%)	
Anterior openbite		19 (3.6%)	17 (3.3%)	36 (3.47%)	0.772
Posterior openbite		5 (0.9%)	8 (1.6%)	13 (1.3%)	0.704

**Significance at $p < 0.01$

Table 5: Association of normative orthodontic treatment need by gender

	Gender			
Orthodontic treatment need	*Male (n = 527)*	*Female (n = 509)*	*Total (n = 1,036)*	*p value*
No need	230 (43.6%)	99 (19.4%)	329 (31.7%)	0.001***
Mild treatment need	92 (17.5%)	105 (20.6%)	197 (19.01%)	
Moderate treatment need	77 (14.6%)	102 (20.0%)	179 (17.27%)	
Severe treatment need	112 (21.3%)	175 (34.4%)	287 (27.7%)	
Extreme treatment need	16 (3.0%)	28 (5.5%)	44 (4.24%)	

***Significance at $p < 0.001$

of Hasan et al.[20] which has reported a prevalence of 18.5% among Kurdistan adolescents (aged 15–19).

An important piece of clinical information in the assessment of the buccal segment of arches is the molar relationship. Several orthodontists have analyzed orthodontic cases according to anterior–posterior–occlusal relationships created on the first molar relationship.[6] Overall, the outcome of the current study proposed that symmetrical class I molar relationships were the greatest public incidence (70.8%), followed by class II (14.1%) and then class III (7.1%). These values were higher than the prevalence of molar classification in Chinese studies: class I (63.0%), class II (24.6%), and class III (11.4%).[21] Meanwhile, our findings were comparable to those of a previous study in Afghanistan, which has reported a prevalence of class I (72.9%), class II (14.2%), and class III (12.9%) malocclusion.[22] About less than a quarter of our subjects had a deviated form of malocclusion, which may influence their life's quality.

The majority of the sample had acceptable overjet (90.3%), in agreement with other studies conducted in China[21] and India.[22] Reverse overjet was detected in 5.3% in the current study, which was higher than the findings of Alajlan et al.[23] (2.9%) on an adolescent Saudi Arabia sample. The prevalence of anterior crossbite in the present study was 11.2%, among which 8.5% had one tooth, 1.8% had two teeth, and 0.9% had three teeth. This prevalence was less than a study of Gudipaneni et al., who reported a prevalence of 4.8%

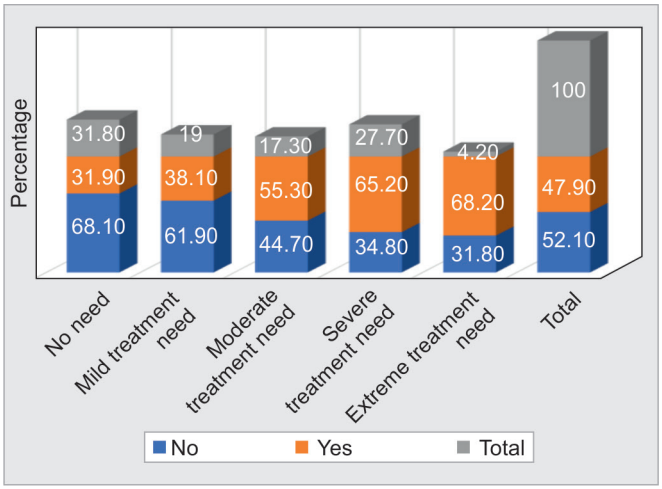

Fig. 2: Relationship between orthodontic treatment need and demand

anterior crossbite, and 9.4% posterior crossbite. Crossbite is related to crowding and paraoral habits that necessitate orthodontic treatment.

In the current study, an overbite overlapping in the middle third or more was found in 10% of subjects and was less frequent than the anterior openbite (16.3%). It was similar to Chaturvedi et al.[24] findings of 10.0% for overbite but less than that for openbite (4.28%). In the current study, we found crossbite in the anterior segment in 5.8% of the sample, posterior segment in 6.5%, and scissor bite in 0.6%. These values were less than those found by Chaturvedi et al.[24] on anterior open bite (8.5%), posterior crossbite (10.6%), and scissor bite (0%). The anterior crossbite was 5.4% of the sample, and the posterior crossbite was 12.2%. Increased value in deepbite consequently increased the difficulty of orthodontic treatment.

The IOTN findings in our study showed that 38.1% of the total subjects required orthodontic treatment. These findings were similar to those of Al-Zubair et al.,[9,10] i.e., 41.8% in university students[9] and 36.6% in 12-year-old children.[10] Both studies were also conducted in Yemen. Meanwhile, the AC findings in our study showed that subjects needed orthodontic treatment; 38.9% of participants reported orthodontic needs, higher than that assessed by the examiner 34.6%. These findings were similar to those of Al-Zubair et al.[9] where 41.8% of subjects preferred to have orthodontic treatment. The difference in results may be attributed to age factor.

The data collected in the present study can serve as a basis to determine the manpower and resources required to achieve adequate orthodontic care and develop a strong argument to plan future orthodontic care in Yemen. Our findings of malocclusion and orthodontic treatment also have important implications in terms of future research and in the planning for orthodontic care in the country.

The present study revealed variability in the prevalence of malocclusions to collect more data for poorly analyzed malocclusion types in Yemen, which can be very useful to obtain accurate assessments of the aforementioned condition. We should recognize that after along spate of civil war, Yemen will be emerging slowly as a modern country. As such, the demand for orthodontic treatment among the younger population may increase in the future. The perceived need for treatment may also increase, meaning more orthodontists will be required in the country. Our study data will be included in the Yemeni database to allow correlation analysis of occlusal features.

The limitations of this study are as follows: the study was performed in Sana'a city; other cities did not have the targeted number, especially in the desert and mountain plateau areas. Some areas are isolated due to a long spate of civil war. Additionally, the geographical terrain is not conductive and cost-effective for the examiners to travel for a follow-up national study, which will be needed to develop the database bank.

Conclusion

Our findings confirmed that malocclusion was an obvious problem in Yemeni adolescents. The normal facial profile showed the highest prevalence, while the lowest was the concave facial profile. According to Angel's classification, the population had a higher percentage of class I than class II and III. This study further showed that the highest was with definite need of treatment. Orthodontic treatment demand was the highest among students in general. Finally, a significant association existed between orthodontic treatment need and demand according to gender.

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