

Anterior Open Bite and Its Challenges in Untreated Orthodontic Patients in Benin City, Nigeria

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ABSTRACT

Objective: Anterior open bite (AOB) is a challenging orthodontic problem which affects the anterior vertical dimension of the face and dentition. Patients with this problem present with challenges which this study aims to determine. The objective of this study is to identify the problems associated with AOB in untreated orthodontic patients in Benin City, Nigeria.

Methods: A total number of 165 untreated orthodontic patients who presented to the clinic were evaluated using the vertical dimension of the occlusion (the Overbite). Four (4) groups were identified namely: Normal Overbite (served as the control group), Incomplete overbite, Anterior Open Bite and Deep Overbite. AOB was determined as an actual vertical gap between the upper and lower incisors with the teeth in centric occlusion. The challenges were identified. Statistical analysis was done with IBM SPSS version 21.0. The student t- test, was used to determine the relationship between variables, frequencies for variables were determined and cross tabulations between variables established. P values at <0.05 were set as significant.

Results: The prevalence of AOB in this study was 66(40%). Normal overbite was seen in 46(27.9%) of the study population, Incomplete overbite in 44(26.7%) and deep overbite in 9(5.4%). The actual vertical gap (AOB) when measured ranged from 1-7mm (SD±1.55mm). The most prevalent AOB value was 4mm and was seen in 28(42.5%). The 21-30-year-old age group had the highest number with AOB in 38(57.6%). Four challenges were identified and included the inability to bite with the anterior teeth (IAB), speech disturbances (SPD), tongue thrusting (TT) and TMJ problems (TMJP). Most of the patients with AOB had a combination of two challenges (IAB+SPD) in 37(30.9%), 28(17.0%) had a combination of three challenges (IAB+SPD+TT) and only one, 1(0.6%) all four challenges (IAB+SPD+TT+TMJP). Those with normal overbite, incomplete overbite and deep overbite had no challenge. Significant values were seen between the age of the patients and AOB challenges, $p < 0.05$ and highly significant values between the AOB value and the overbite and AOB challenge.

Conclusion: AOB challenges were identified in this study. The larger the AOB value, the greater the challenge.

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INTRODUCTION

Anterior Open Bite (AOB) is defined as an actual open vertical gap between the incisal edges of the maxillary and mandibular anterior teeth (Subtelny and Sakuda, 1964).

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Mizrahi described anterior open bite as a vertical discrepancy whereby the upper incisor crowns fail to overlap the incisal third of the lower incisor crowns when the mandible is brought into full occlusion (Mizrahi, 1978). Ferguson, described AOB as the absence of vertical incisor overlap between the maxillary and mandibular incisors, whereas an incomplete overbite has vertical overlap, but without tooth or tissue contact in the anterior segment (Ferguson, 1995). In the United States, both conditions have been referred to as an anterior open bite (Ferguson, 1995).

AOB may be as a result of many factors and the aetiology a combination of skeletal, dental and soft tissue factors. It may occur as a result of an interaction between factors, which include hereditary (Sassouni, 1969; Mizrahi, 1978) and environmental factors. Environmental factors include variations in dental eruption and alveolar growth; disproportionate neuromuscular growth or aberrant neuromuscular function related to malfunctions of the tongue or oral habits or both (Mizrahi, 1978; Ferguson, 1995; Otuyemi & Noar, 1997; Agbaje et al, 2012;). Unfavourable growth patterns (Bell, 1971; Nahoum, 1977), digit sucking habits (Subtelny & Sakuda, 1964; Mizrahi, 1978), enlarged lymphatic tissue (Subtelny & Sakuda, 1964), heredity (Sassouni, 1969; Mizrahi, 1978) and oral functional matrices (Moss and Salentijn, 1971) have also been identified as possible aetiological factors in the formation of an anterior open bite.

AOB is described as a dental open bite when the dentition alone is involved and a skeletal open bite when it involves the vertical facial form (Subtelny & Sakuda, 1964; Bell, 1971; Nahoum 1977; Mizrahi, 1978; Ferguson, 1995). There is a general agreement among orthodontists that patients with AOB are challenging to treat, and relapse is common after treatment with orthodontics alone or combined with orthognathic surgery (Subtelny & Sakuda, 1964; Mizrahi, 1978; Ferguson, 1995; Agbaje et al, 2012). Various treatment options are available for the treatment of AOB and is dependent on the age of the patient and severity of the open bite. These may begin with counselling about cessation of parafunctional habits (Klocke et al, 2002; Cozza et al 2005), interceptive treatment (Bell, 1971), camouflage treatment using orthodontics only, and a combined orthodontic and surgical approach Bell, 1971; Mehjabeen et al, 2018).

With a true anterior open bite, it is impossible to achieve incisor contact while the teeth are in centric occlusion and the posterior teeth in contact, whereas in patients with incomplete overbite this contact may sometimes be accomplished if the mandible is protruded (Agbaje

et al., 2012). Otuyemi & Noar described anterior open bite as a relationship that exists when there is no incisor contact and vertical overlap of lower incisors by the upper incisors. It may occur with an underlying Class I, Class II or Class III skeletal pattern (Otuyemi & Noar, 1997).

AOB affects the anterior occlusion and also alters aesthetics (Klocke et al., 2002). It also affects mastication and phonetics which is the formation of certain sounds with the coming together of the teeth, tongue, palate, palatal rugae, lips and oropharynx (Parra et al., 2015). Studies have shown that people with AOB are unable to effectively communicate as their capability to verbally communicate and speak correctly may be compromised (Doshi & Bhad-Patil, 2011). Other studies have found challenges associated with AOB to include pain on the temporal side of the head, masseter and zygomatic facial pain and soreness, Cervical neck (sternocleidomastoid – SCM) pain, Shoulder pain, Pain at the lower border and corner of the mandible (Chan, 2019).

Differences exist among racial groups in the prevalence of AOB (Otuyemi & Noar, 1997). The occurrence of AOB ranges from 1.5% to 11% among various age and ethnic groups, and it has been shown that approximately 17% of orthodontic patients in the United States have AOB (Gile, 1972). In the United Kingdom, the reported incidence in adults is about 4% and in children is 2-4% (O'Brien, 1993), falling from the age of nine to the early teens. This was determined by a study (O'Brien, 1993) which found out that adults have matured with the occlusal development stabilized, a cessation of the oral habits, and a decrease in size of the adenoids and the establishment of a normal adult swallowing pattern. The incidence of AOB then increases again during the mid-teens probably as a result of late vertical growth (O'Brien, 1993). Other studies have shown that AOB is more common in Africans with a prevalence in adults of between 5.23 to 8.5% (Para et al., 2015). There however appear be no Nigerian studies on the challenges associated with AOB hence the need for this current study.

The objective of this study was to evaluate the prevalence and challenges of anterior open bite in untreated orthodontic patients in Benin City, Nigeria.

MATERIALS AND METHODS

This cross-sectional analytical study was carried out on pre-treatment orthodontic patients at the University of Benin Teaching Hospital after obtaining clearance from the Ethical Committee of the hospital. A total number of 165 untreated orthodontic patients who presented to the clinic

over a six (6) month period (Jan 2019-June 2019) were evaluated using the vertical dimension of the occlusion (the overbite). Inclusion criteria were patients in the permanent dentition, no previous history of orthodontic treatment and no medical or surgical history that may affect occlusion or speech. Patients with asymmetrical anterior open bites, generalized spacing, and diastema were excluded from this study.

Occlusion was determined when the patient was seated in a dental chair with the occlusal plane flat and parallel to the floor and the teeth in centric occlusion. This was obtained by asking the patient to swallow and the researcher's (ONJ) thumb and forefinger placed on the chin and the lower jaw guided into centric occlusion. AOB was measured by placing an orthodontic metal ruler vertically from the incisal edge of the upper central incisor and the anterior opening to the incisal edges of the lower central incisors and the value measured in millimetres.

The overbite was obtained by measuring the cervico-incisal length of the lower central incisor with the patient's mouth opened. The patient's mouth was closed in centric occlusion and where the incisal edges of the upper anterior teeth meet the labial aspect of the lower incisors, a mark was made with an orthodontic pencil. The distance between the incisal edges of the lower incisors to the mark is the overbite, measured in millimeters. The overbite percentage was calculated with the formula: *Overbite / cervico-incisal length of lower incisor X 100*

The value obtained was approximated to the nearest whole number. Overbite value and percentage was determined using the description of Ferguson³ and stated as below:

- Normal Overbite- The upper incisors overlap at least $\frac{1}{3}$ rd to $\frac{1}{2}$ of the lower incisors (values of 30-50%)
- Incomplete overbite – There is a vertical overlap of the upper and lower incisors but no tooth or tissue contact in the anterior region (values of 1-29%)
- Anterior Open bite – There is an actual vertical gap between the upper and lower incisors with the teeth in centric occlusion (values of 0%)
- Deep overbite – The upper incisors overlap more than $\frac{1}{2}$ to all of the lower central incisors (51-100%)

The actual vertical gap between the incisal edges of the upper and lower incisors with the teeth in centric occlusion was measured with a metal orthodontic ruler in millimetres and recorded as the AOB.

Four (4) groups were identified namely: Normal overbite (served as the control group), Incomplete overbite, AOB and Deep Overbite.

The following challenges which are as follows; inability to bite with anterior teeth, speech lisping, tongue thrusting and TMJ problems were identified and recorded.

Molar relationship was determined using Angles Method of classification (Angle, 1899) and classes I, II and III recorded based on the articulation of the mesiobuccal cusp of the upper first molar biting on the buccal groove of the lower first molar (Class I) or ahead of the groove (Class II) or behind the groove (Class III).

Statistical analysis was done with statistical package for social sciences software (SPSS) version 21.0. The student t-test, frequencies for variables were determined and cross tabulations between variables established. P values at <0.05 were set as significant.

RESULTS

There were a total number of 165 patients with 109 (66.1%) females and 56 (33.9%) males. Individuals within the age range of 21-30 years constituted the highest number with 96 (58.2%), while the mean age of the total population was 25.46±6.4 years.

Skeletal pattern was Class 1 in 148 (89.7%), Class 2 in 3 (1.8%), while Class 3 was seen in 14 (8.5%). Those with Class I molar relationship (Angles' classification) were 111 (67.3%), Class II were 21 (12.7%), while Class III were 33 (20.0%). AOB values were recorded as a range from 1-7mm±1.55

The cervico-incisal length of the lower central incisor ranged from 7-11mm±2.306. The most prevalent length was 11mm in 108(65.5%) while the least prevalent length was 8mm in 2(1.2%).

Table 1 shows the distribution of overbite percentage with normal overbite, incomplete overbite, AOB and deep overbite. The overbite percentage in AOB was 0% and was seen in 66(40%). The incomplete overbite with an overbite percentage value of 9-28% was seen in 44(26.7%) of the studied population.

Figure 1 demonstrates the AOB values measured in millimetres (mm). Incomplete overbite with vertical measured values of 0-0.5mm was seen in 44(26.7%) while AOB with values ranging from 1-7mm seen in 66 (40%).

Figure 2 shows AOB challenges and those with inability to bite with the anterior teeth and speech lisping were the highest in 69 (41.8%), while those with inability to bite with anterior teeth, speech lisping, tongue thrusting and TMJ problems was lowest in 1 (0.6%).

There was no significant relationship between age groups and AOB but the 21-30-year-old age group had the highest number of those with AOB in 38(57.6%). Also, AOB of 4mm was most prevalent in 28(42.4%) (Table 2).

However, Table 3 shows the correlation between the Age groups and AOB Challenges with the 21-

30-year-old age group being more with two challenges (inability to bite with the anterior teeth and speech alterations) in 37(30.9%).

Figures 3 and 4 illustrated a patient with AOB and tongue thrusting challenges.

Table 1: Comparison of AOB, Incomplete overbite, Normal Overbite and Deep Overbite with the Overbite measured as a percentage

Classification of overbite	Total Sample n=165 Overbite percentage %	Frequency (n)	Percent %
AOB	0	66	40
Incomplete overbite	9-13 14-17 18-26 27 28-29 Total	5 10 6 19 4 44	3.0 6.1 3.6 11.6 2.4 26.7
Normal overbite	30-32 33-37 38-44 45-49 50 Total	12 2 5 4 23 46	7.3 1.2 3.0 2.4 13.9 27.9
Deep Overbite	64-77 68-72 73-81 82-90 91-99 100 Total	1 1 3 1 1 2 9	0.6 0.6 1.8 0.6 0.6 1.2 5.4

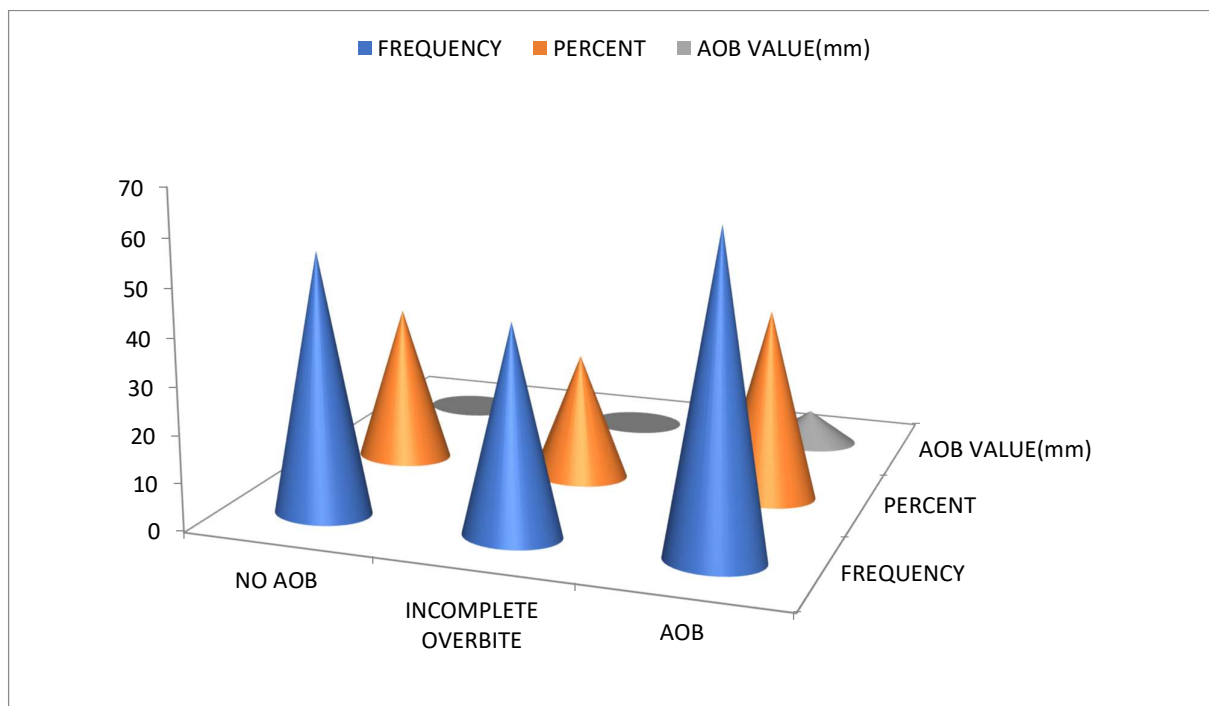


Figure 1: Comparative evaluation of measured AOB values

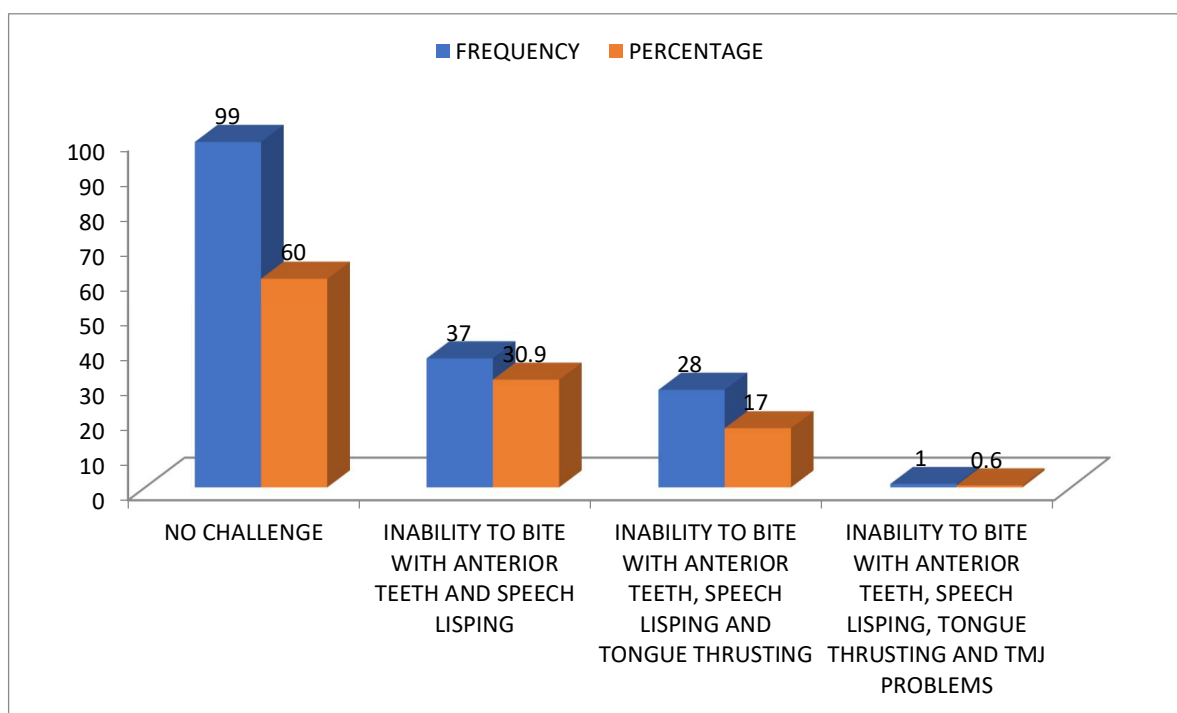


Figure 2: Distribution of AOB challenges

Table 2: Comparison between age group and AOB value

AOB VALUE (mm)	Age group (years)			Total
	10 - 20 n(%)	21 - 30 n(%)	≥31 n(%)	n(%)
1.00	2(28.6)	13(34.2)	1(4.8)	16(24.2)
1.50	0(0)	2(5.3)	0(0)	2(3.0)
2.00	4(57.1)	5(13.2)	7(33.3)	16(24.2)
3.00	0(0)	2(5.3)	1(4.8)	3(4.6)
4.00	1(14.3)	15(39.4)	12(57.1)	28(42.5)
7.00	0(0)	1(2.6)	0(0)	1(1.5)
Total	7(10.6)	38(57.6)	21(31.8)	66(100.0)

P>0.05

Table 3: Correlation between the various age groups and AOB challenge

Age Group (years)	AOB CHALLENGES				Total
	No AOB NO Challenge	Inability to bite with anterior teeth, Speech lisping	Inability to bite with anterior teeth, Speech lisping, Tongue thrusting	Inability to bite with anterior teeth, Speech lisping, Tongue thrusting, TMJ problems	n(%)
	n(%)	n(%)	n(%)	n(%)	n(%)
10 – 20	27(27.3)	3(8.1)	4(14.3)	0(0)	34(100)
21 – 30	58(58.6)	26(70.3)	11(39.3)	1(100.0)	96(100)
≥31	14(14.1)	8(21.6)	13(46.4)	0(0.0)	35(100)
Total	99(60)	37(30.9)	28(17.0)	1(0.6)	165(100)

P<0.05, Chi-Square 0.037



Figure 3: Picture of AOB of 4mm with three challenges (the inability to bite with the anterior teeth (IAB), speech disturbances (SPD), tongue thrusting (TT) (Anterior View)



Figure 3: Picture of AOB of 4mm with three challenges (the inability to bite with the anterior teeth (IAB), speech disturbances (SPD), tongue thrusting (TT) (Lateral View)

DISCUSSION

Anterior open bite (AOB) exists amongst all populations, age groups and races with different prevalence rates seen. This current study recorded a prevalence of 40% of AOB amongst untreated orthodontic patients in Benin City Nigeria. Various studies on the prevalence of AOB were seen in 2.8% in pre-school children in Nigerians (Ize-Iyamu & Isiekwe, 2012), 4.1% in Yemeni Adults and 8.5% (Dae'r & Abuaffan, 2016), in Adult Sudanese (Hassan and Abuaffan 2016). These were however epidemiologic studies (Ize-Iyamu & Isiekwe, 2012; Dae'r & Abuaffan, 2016), and probably explain why their values were much lower than those from this current study. Clinical studies that targeted orthodontic patients or those with AOB (Hassan & Abuaffan, 2016) however recorded higher values. A study by Lopez-Perez et al recorded AOB values in Down syndrome children and controls as 31.6% and 22.8% respectively (Lopez-Perez et al., 2008; Hassan & Abuaffan, 2016). While these studies showed lower prevalence rates, when compared to the epidemiologic studies and to this present study, the values were higher. Studies from the USA show that approximately 17% of orthodontic patients have AOB (Cozza, 2005) and 16.5% are Afro-Americans (Zuroff et al., 2010). A similar study on pre-treatment orthodontic patients in Saudi Arabia (Alyami et al., 2019) showed a prevalence of AOB in 42.4% which is similar to what was obtained from this current study. This could be due to the fact that both were clinical studies and in patients seeking care for orthodontic

problems. Also, AOB has been shown to be higher in Africans and Asians (Zuroff et al., 2010; Dae'r & Abuaffan, 2016; Hassan & Abuaffan, 2016) and also to have a higher percentage in pre-orthodontic patients (Alyami et al., 2019).

This study showed that AOB was present in skeletal class 1, class 2 and class 3; with Class 1 being most prevalent. Majority of the patients who presented for orthodontic management from this current study were a skeletal class 1 so this may account for the higher percentage of those with AOB in Skeletal class 1. This is also in agreement with other studies (Agbaje et al., 2012; Otuyemi & Noar, 1997; Alyami et al., 2019) where the distribution was more of a skeletal class 1.

Overbite is a major consideration when determining AOB and while studies have measured overbite in millimetres (Kelly and James 1977) or percentages, agreements exist that overbites may be categorized as normal, incomplete, anterior open bite and deep bite (Kelly & James, 1977; Ferguson, 1995; Brunelle et al., 1996; Dae'r & Abuaffan, 2016; Hassan & Abuaffan, 2016). A normal overbite was seen in a US Study (Kelly & James, 1997) in 45.9%. A normal overbite in this current study was seen in 29.7% which is below the value from the other study (Kelly & James, 1977). AOB from this current study with an overbite percentage of 0 was high in 40%. Most studies did not measure or calculate overbite percentage or the actual vertical gap of the anterior opening. The AOB from this study ranged from 1-7mm with a

4mm vertical gap anteriorly being most prevalent in 42.5%.

This study showed that AOB challenges were higher in females when compared to males. This is in agreement with previous studies which showed a higher prevalence of AOB in females (Lopez-Perez 2008; Ize-Iyamu & Isiekwe, 2012; Machado et al., 2014; Dae'r & Abuaffan, 2016; Hassan & Abuaffan, 2016). This may also be because there were a higher number of females in this current study than males. There appear to be no studies from a search of the literature which compared the relationship between gender and AOB challenges. Studies show that patients with AOB or deep overbite tend to have more challenges (Kelly & James 1977; Ngan & Fields, 1997; Klocke et al, 2002; Doshi & Bhad-Patil, 2011; Parra et al, 2015; Pacheco et al 2015). The challenges identified from this study with those participants with AOB included speech defect, inability to bite with the anterior teeth, tongue thrusting and Temporomandibular Joint (TMJ) pain or discomfort. Studies by Ngan et al (Ngan & Fields, 1997) identified pain dysfunction symptoms with AOB and deep bite in 72%. TMJ clicking and dental wear was also identified with AOB suggested as the causative factor (Ngan & Fields, 1997). In a Japanese study, 5.4% of study participants with AOB had temporomandibular disorders (Motegi et al, 1992). Speech disorders have been identified with patients with AOB (Klocke et al, 2002; Doshi & Bhad-Patil, 2011; Parra et al., 2015) and also a combination of AOB and Down syndrome and also in the control group with a family history of AOB (Lopez-Perez, 2008). Other studies identified speech disorders (Johnson & Sandy, 1999; Klocke et al., 2002; Doshi & Bhad-Patil, 2011; Parra et al., 2015) in AOB and one study suggested irregularities of the teeth in addition to AOB (Johnson & Sandy 1999) may be the cause of the speech disorder. Other studies varied in whether AOB was as a result or sequelae of habits (Subtelny & Sakuda, 1964; Mizrahi, 1978; Ferguson, 1995; Otuyemi & Noar, 1997; Klocke et al., 2002; Agbaje et al., 2012). This study has shown that inability to bite with the anterior teeth and speech lisping was the highest challenge in 41.8%. This is in agreement with other studies where phonetics and speech lisping were identified in patients with AOB (Johnson & Sandy 1999; Klocke et al, 2002; Lopez-Perez et al., 2008; Doshi & Bhad-Patil, 2011; Parra et al, 2015; Pacheco et al., 2015).

Age has also shown variation in the prevalence of AOB with the 21-30 year-old age group with a higher prevalence from this study in 57.6%. However, there was no significant difference between age group and AOB values. While

previous studies showed an increase prevalence of AOB with an increase in age from the deciduous dentition (Klocke et al 2002; Ize-Iyamu & Isiekwe, 2012; Mehjabeen et al 2014;) to the mixed dentition and permanent dentition (Otuyemi & Noar 1997; Tausche et al, 2004; Parra et al, 2015; Hassan & Abuaffan 2016; Alyami et al, 2019), they were consistent that higher prevalence's and values were more in older individuals. There appears to be no other study which compared age group and AOB challenges.

This study demonstrated that larger AOB values were associated with a higher number of challenges. Studies have shown that TMJ problems may be seen in abnormally large AOB values (Motegi et al., 1992). This is in agreement with this study where an AOB value of 7mm was associated with TMJ problems in addition to the other challenges of speech, inability to bite with the anterior teeth and tongue thrusting. Also, tongue thrusting has been identified as an AOB challenge in this study in 17%. Other studies have identified tongue thrusting as a challenge from an already existing AOB (Johnson & Sandy 1999; Pacheco et al., 2015; Mehjabeen et al., 2018). The most prevalent AOB value from this study was 4mm and was seen across all age groups.

CONCLUSION

In conclusion, this study revealed that AOB is a common problem seen in pre orthodontic patients and AOB challenges exist with higher AOB values. The greater the AOB value, the more the challenges.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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