ABSTRACT

Objective: Malocclusion is every difference in the arrangement of teeth beyond the standard of regular occlusion illustrated by anomalies within the dental arches. The purpose of this study was to measure prevalence of malocclusion between primary school children in Sana’a city Yemen.

Methods: A cross sectional study was conducted on 1079 school children (546 girls and 533 boys), their age ranged from 7 to 12 years old from public and private schools selected randomly in Sana’a City, Yemen. The prevalence of malocclusion was investigated according to age, gender and school type based on Angle's classification.

Results: The study showed that the overall prevalence of malocclusion among school children was 81.1%, in which Class I normal molar association was found only in 18.9% of school children, while Class I malocclusion included the highest percentage of the sample 70.4%, followed by Class II relation 9.5%, and Class III involved only 1.1%. The most prevalent malocclusion trait was spacing 35.7%, whereas the crowding was present in 30.0% of the sample. The deep bite was present in 10.1% followed by anterior crossbite 8.8%, midline diastema 8.6%, anterior open bite 4.5%, posterior crossbite 4.0%, and the least noted malocclusion trait was posterior open bite 0.4%.

Conclusion: In conclusion, there was a high rate of malocclusion in school children and significantly increased with age, class I malocclusion was the most common followed by Class II malocclusion, while Class III was the rear. The most prevalent occlusal problem was spacing, followed by crowding. Thus, 7-12 year-olds can benefit from interceptive and preventive oral health procedures which may either entirely prevent or reduce the development of serious types of malocclusions afterward in their lives.

Keywords: Malocclusion, prevalence, primary school children, Yemen

INTRODUCTION

Research and study of dental health problems in Yemen are still modest and limited, although there have been studies that have addressed the problems of tooth decay, gum infections, causes for extraction of permanent teeth and prevalence and pattern of third molar impaction in adults and children, but no research has touched upon malocclusion. Malocclusion is a problem of the oral cavity scattered around the world, from which the children and adults suffer, not less important than other oral problems. Although dental malocclusion is not a life-threatening condition, the poor periodontal conditions and impaired mastication associated with it provoke the need to explore the prevalence of malocclusion in different age groups. Furthermore, it is one of the most common dental problems, together with dental caries, gingival disease and dental fluorosis. It is considered as dental public health problem, its impact psychologically and functionally is great, and its prevalence among children is high. In addition to that, malocclusion is thought to be a risk factor information and progression of dental caries. Since pediatric patients with malocclusion have challenged the ability to practice effective oral hygiene, this may predispose them to malocclusion. Concerning premature loss of primary teeth, it has been previously stated that the premature loss of primary teeth can affect the normal eruption time of the permanent successors by either retarding or accelerating their emergence. It is considered a
Dental malocclusion prevalence among school children have been reported in most countries of the world. There were few studies on the prevalence of malocclusion in Yemen, and only two studies were conducted in Sana’a City in 2014 by Al-Zubair and Ghandour16, and Al-Zubair and Al- Almulla17. It is clear to see the need to study prevalence of malocclusion in Yemeni school children during mixed dentition period to provide basic values for preventive measures and then to know and reduce the potential irregularities in the developing dental-facial complex in future. The importance of this study comes from the great effects of malocclusion defects on children’s oral, systemic and psychological health.

SUBJECTS AND METHODS
This descriptive cross-sectional study was conducted to measure the prevalence of malocclusion among Yemeni school children of primary schools (Government and private) in Sana’a City, Yemen. A total of 1079 boys and girls aged between 7-12 years old from schools of Sana’a were randomly selected and examined, the schools are located in different regions of the city to avoid having children from the same area. The data collection was performed by one examiner; the researcher (Tharwa), by using the standard method18. The clinical examination for each child with dental and medical history was formed by simple inspection under adequate light, sometimes if the natural light was insufficient, artificial light from a torch was utilized. All children were examined in a room of the school selected by the principles of the school. Those children who were selected and refused to participate were excluded replaced with new one.

Before starting the study, ethical considerations were taken after the approval of the study by the Faculty of Dentistry in Sana’a University, Yemen. The examination was conducted with permission from the concerned education authorities. Permission was obtained from the office of the region education and the principals of the targeted schools and after obtaining informed consent from parents of the participating children. The examination assessed the period of dentition and analysis of occlusal data, by using a separate registration chart designed to record the personal data of the subjects (all information and clinical examination).

Statistical Analysis
The data were analyzed by SPSS program (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) and presented by using tables. Percentage (%) was used to describe the qualitative variables. Chi-square with Yate correction and Fisher tests were used to show the significance of the association between the outcomes at the level of significance less than 0.05 (P).

RESULTS
The results in Table 2 indicate that the prevalence of total malocclusion among school children was 81.1%, and there was significant difference between malocclusion according to age group 7-9 years old (84.2%) and 10-12 years (78.1%). Also a similar prevalence of malocclusion was found in boys and girls, government schools, and private schools (Table 2). The results in (Table 3) indicate that class I malocclusion has the highest proportion of the sample 70.4%, with 73.2% in the 7-9 age group higher than the 10-12 age group (67.8%) (P<0.05). The class II malocclusion was at 9.5%, while the class III had the lowest incidence and was only present in 1.1% of the entire sample.

Table 1: The distribution of school children participants in the study according to age, gender, school type and district (n=1079)

| Variable         | Frequency | %    |
|------------------|-----------|------|
| Age              |           |      |
| 7-9yrs           | 527       | 48.8 |
| 10-12yrs         | 552       | 51.2 |
| Gender           |           |      |
| Boys             | 546       | 50.6 |
| Girls            | 533       | 49.4 |
| School type      |           |      |
| Government       | 761       | 70.5 |
| Private          | 318       | 29.5 |
| Al-Thawrah       | 669       | 62.0 |
| Old Sana’a       | 170       | 15.8 |
| Al-Safiah        | 240       | 22.2 |

| Districts        | Frequency | %    |
|------------------|-----------|------|
| Total (n=1079)   | 875       | 81.1 |

Mean age ±SD= 9.5±1.7

Table 2: The prevalence of malocclusion according to age, gender and school type

| Variable | Malocclusion | Normal | p-value |
|----------|--------------|--------|---------|
|          | Frequency    | Frequency | %     |
| Age (year) |              |          |       |
| 7 - 9 yrs.     | 444         | 84.2    | 83     | 15.7 | 0.010* |
| 10 - 12 yrs.   | 431         | 78.1    | 121    | 21.9 |
| Boys          | 443         | 81.1    | 103    | 18.9 |
| Gender         |              |          |       |
| Girls          | 432         | 81.1    | 101    | 18.9 |
| School type    |              |          |       |
| Government     | 620         | 81.5    | 141    | 18.5 |
| Private        | 255         | 80.2    | 63     | 19.8 |
| Total (n=1079) | 875         | 81.1    | 204    | 18.9 |

* P<0.05 statistically significant
According to age, there was significant difference with class II malocclusion (P< 0.05). On the other hand, a normal class I occlusion was in 18.9% of the sample. 21.9% were found for age group 10-12 years older than that of age group 7-9 years (15.8%), also the age difference was significant. The most prevalent malocclusion trait was spacing 35.7%. According to age groups, the highest rate of spacing was found in 7-9 years old 42.0%, comparing to age group 10-12 years old 29.7% (X²=17.76, P<0.001), while non-significant difference of spacing malocclusion was found regarding gender and school type (Table 4). The proportion of school children with dental crowding was 30.0%, with a non-significant difference that in age groups, gender and school type (P > 0.05) (Table 5). The most prevalent malocclusion trait was spacing 35.7%, whereas the crowding was present in 30.0% of the sample. The deep bite was present in 10.1% followed by anterior crossbite 8.8%, midline diastema 8.6%, anterior open bite 4.5%, posterior crossbite 4.0%, and the least noted malocclusion trait was posterior open bite 0.4% (Table 6).

**DISCUSSION**

The prevalence of malocclusion varies from country to country and between different age and nationality groups. Globally, epidemiological studies indicate that the prevalence of malocclusion is between 39% and 93%18. In the present study, malocclusion was demonstrated in 81.1% of the school children. By comparing the result of this study to other studies, there was almost an agreement with the following reported studies14 80.84%,13 86.6%, and20 83.3%.

### Table 3: Prevalence of Angle classification according to age, gender and school type

| Angle classification | 7-9yrs | 10-12yrs | Boys | Girls | Government | Private | Total |
|----------------------|-------|----------|------|-------|------------|---------|-------|
| Class I normal       | 83    | 15.8     | 121  | 21.9  | 103        | 18.9    | 18.9  |
| Class I              | 386   | 73.2     | 374  | 67.8  | 384        | 70.3    | 70.5  |
| Class II             | 52    | 9.9      | 51   | 9.2   | 53         | 9.7     | 9.4   |
| Class III            | 6     | 1.1      | 6    | 1.1   | 10         | 1.3     | 1.1   |

P-value: 0.085*
X²: 6.24

* P< 0.05 statistically significant

### Table 4: Prevalence of spacing according to age, gender and school type and the association of spacing with premature loss of teeth

| Variable              | Present | Absent | X²   | P-value |
|-----------------------|---------|--------|------|---------|
| Age                   | 7-9 yrs.|        |      |         |
| (year)                |         |        |      |         |
| 7-9 yrs.              | 221     | 42.0   | 306  | 58.0    | 17.76 | <0.001** |
| 10-12 yrs.            | 164     | 29.7   | 388  | 70.3    | 1.08  | 0.298   |
| Gender                |         |        |      |         |
| Boys                  | 203     | 37.2   | 343  | 62.8    | 0.24  | 0.622   |
| Girls                 | 182     | 34.1   | 351  | 65.9    | 1.08  | 0.298   |
| School type           |         |        |      |         |
| Government            | 268     | 35.2   | 493  | 64.8    | 0.862 | 0.353   |
| Private               | 117     | 36.8   | 201  | 63.2  | 0.24  | 0.622   |
| Premature teeth losing| 104     | 33.5   | 206  | 66.5  | 0.862 | 0.353   |
| Total                 | 385     | 35.7   | 694  | 64.3  |      |         |

** P< 0.001 statistically significant

Alternatively, this result was slightly higher when compared to Almeida et al.21 73%, (Reddy et al.22 52%, Morais et al.,23 78.50%, Disha et al.,24 40.9%, Sultan,25 78.31%, and Yu et al.,26 79.4%). The variation in the prevalence of malocclusion can be attributed to the differences in the age ranges of the populations studied, the number of subjects examined and differences in the registration methods which are probably the most important factors explaining these variations.9 Regarding gender, no statistical significant difference (P > 0.05) was observed between boys and girls with respect to the prevalence of malocclusion (Table 2), coinciding with Das et al.,27; Souza et al.,28; Narayanan et al.,29 According to age groups, the prevalence of malocclusion was more noticeable for the age group 7-9 years compared to the age group 10-12 years, with a statistical significant difference (P < 0.05). This finding is consistent with Morais et al.,23 Variation in malocclusion can appear between age groups due to age and individual differences, or perhaps a shift from Class II malocclusion to the normal occlusion that occurs from the mesial movement of the first molars in the lower jaw where the second primary molars exfoliated22 The prevalence of normal occlusion was found low in the present study (18.9%) comparing with other studies by Alatrach et al.,28 (38.5%), Reddy et al.,22 (48.30%), Al-Zubair and Ghandour.16 (69.4%), and Disha et al.,24 (59.1%). However, this result almost corresponds with the data in some other studies by Souza et al.,28 (22.3%), Morais et al.,23 (21.50%), and by Narayanan et al.,20 (16.7%). These disparities between the high malocclusion and low normal occlusion prevalence that was found in this study may explain the low preventive measure and treatment services.

The results of this study showed that Class I malocclusion prevailed over Class II and Class III (Table 3), in agreement with the majority of the previous studies.23,28 On the other hand, few studies by Gonçalves et al.,31; Freitas et al.,34; and by Yu et al.,36 emphasized the predominance of Class II, in comparison with relation Class I and Class III. This
variation of results may be explained by the regional differences, age and sample size, or by the fact of considering normal occlusion as being Class I and maybe by the diversity of the used methodology. Furthermore, Class I malocclusion included the highest proportion of the sample (70.4%) (Table 3). This finding resembles who found that the most common malocclusion was Class I (70.4%).

Table 5: Prevalence of crowding according to age, gender and school type

| Variable          | Present |          | Absent |          | \( \chi^2 \) | p-value |
|-------------------|---------|----------|--------|----------|-------------|---------|
| Age (year)        | Freq.   | %        | Freq.  | %        |             |         |
| 7 - 9yrs.         | 163     | 31.0     | 364    | 69.0     | 0.43        | 0.514   |
| 10 - 12yrs.       | 161     | 29.2     | 391    | 70.8     | 1.41        | 0.234   |
| Gender            | 155     | 28.4     | 391    | 71.6     |             |         |
| Boys              | 169     | 31.7     | 364    | 68.3     |             |         |
| Girls             | 222     | 29.2     | 539    | 70.8     |             |         |
| School type       | 102     | 32.1     | 216    | 67.9     | 0.90        | 0.343   |
| Government        | 324     | 30.0     | 755    | 70.0     |             |         |
| Private           |         |          |        |          |             |         |

This finding also coincides with results of other studies, where malocclusion of Class I was found to be the predominant one by Brito et al., (76.7%), Bourzgui et al. (61.4%), Narayanan et al. (69.8%) and by Sultan, (65.87%). In contrary Class I malocclusion in this study was higher than that found by Alajlan (5.9%), Souza et al., (47.6%), Almeida et al., (55.25%), Alatrach et al., (30%), and by Disha et al., (36.4%) studies.

Table 6: The association of occlusal problem with age groups, gender and school type.

| Variable               | Age             | Gender          | School type     | Total           |
|------------------------|-----------------|-----------------|-----------------|-----------------|
| Angle classification   | 7 - 9 years     | 10- 12 years    | Boy            | Girl           |
| Class I normal         | 83   | 15.8 | 121  | 21.9 | 103  | 18.9 | 101  | 18.9 | 141  | 18.5 | 63   | 19.8 | 204  | 18.9 |
| Class I (malocclusion) | 385  | 73.2 | 374  | 67.8 | 384  | 70.3 | 376  | 70.5 | 540  | 71.0 | 220  | 69.2 | 760  | 70.4 |
| Class II               | 52   | 9.9  | 51   | 9.2  | 53   | 9.7  | 50   | 9.4  | 70   | 9.2  | 33   | 10.4 | 103  | 9.5  |
| Class III              | 6    | 1.1  | 6    | 1.1  | 6    | 1.1  | 6    | 1.1  | 10   | 1.3  | 2    | 0.6  | 12   | 1.1  |
| Spacing                | 221  | 42.0 | 164  | 29.7 | 203  | 37.2 | 182  | 34.1 | 268  | 35.2 | 117  | 36.8 | 385  | 35.7 |
| Crowding               | 163  | 31.0 | 161  | 29.2 | 155  | 28.4 | 169  | 31.7 | 222  | 29.2 | 102  | 32.1 | 324  | 30.0 |
| Deep bite              | 45   | 8.6  | 46   | 11.6 | 53   | 9.7  | 56   | 10.5 | 83   | 10.9 | 26   | 8.2  | 109  | 10.1 |
| Cross-bite (Anterior)  | 60   | 11.4 | 34   | 6.2  | 47   | 8.6  | 48   | 9.0  | 65   | 8.5  | 30   | 9.4  | 95   | 8.8  |
| Midline diastema       | 51   | 9.7  | 42   | 7.6  | 27   | 4.9  | 66   | 12.4 | 76   | 10.0 | 17   | 5.3  | 93   | 8.6  |
| Open bite (Anterior)   | 37   | 7.0  | 12   | 2.2  | 17   | 3.1  | 32   | 6.0  | 39   | 5.1  | 10   | 3.1  | 49   | 4.5  |
| Cross-bite (Posterior) | 17   | 3.2  | 26   | 4.7  | 22   | 4.0  | 21   | 3.9  | 30   | 3.9  | 13   | 4.1  | 43   | 4.0  |
| Open bite (Posterior)  | 1    | 0.2  | 3    | 0.5  | 1    | 0.2  | 3    | 0.6  | 2    | 0.3  | 2    | 0.6  | 4    | 0.4  |

In terms of Class II malocclusion, a prevalence of 9.5% was found in the present study. This result is almost similar to the findings of Narayanan et al., (9.3%) in contrast higher rate of Class II in that reported by Brito et al., (19.2%), Almeida et al., (38%), Bourzgui et al., (24%), Reddy et al., (13.9%), Sultan, (21.93%), and by Alajlan, (21.3%), while current result was higher than that reported by Disha et al., (3.9%). On the other hand, Class III malocclusion was found only in 1.1% (Table 3). This result was higher when compared to finding of Disha et al., 0.6%, and lower as compared to that of Souza et al., (8.2%), Brito et al., (4.2%), Lux et al., (3%), Almeida et al., (6.75%), Bourzgui et al., (10%), Romano et al., (6.0%), Reddy et al., (7.8%), Alatrach et al., (12%), Narayanan et al., (4.1%), Sultan, (12.18%), Alajlan, (8.3%), and by Yu et al., (5.9%). In the present study, the most prevalent malocclusion trait in this 9 years old 42.0%, compared to the 10-12 years old 29.7%. By comparing with other studies, this result is much higher than that found by Disha et al., (6.5%) and by Yu et al., (9.5%). The second most common type of malocclusion trait in this
study was crowding seen in 30.0% of school children (Table 5). This finding is almost in agreement with that of Almeida et al., Al-Zubair and Ghandour, Al-Zubair and Al-Almulla, and by Yu et al., however, the number of crowding in this study is much lower than that reported by Souza et al., Brito et al., and by Romano et al., According to gender, a non-significant difference in crowding was observed (P > 0.05) (Table 5). This finding is in agreement with Brito et al., and in disagreement with Souza et al., who found a significant difference between genders (P < 0.05) in which the dental crowding in girls was higher than in boys. On the other hand, the results has shown that there is a higher prevalence of dental crowding for age group 7-9 years old than for age group 10-12 years old (Table 5). This result is in agreement with that found by Morais et al., This may be partially explained by the fact that some dental crowding may have, spontaneously, resolved. Mixed dentition crowding, known as temporary primary crowding, may resolve spontaneously during the stage of mixed dentition.

CONCLUSION
There was a high rate of malocclusion in school children and significantly increased with age. Class I malocclusion was the most common followed by Class II malocclusion, while Class III was the rear. The most prevalent occlusal problem was spacing, followed by crowding. This study could open the field of specific studies to determine the means for the proper identification, control, and guidance of the environmental factors that could affect the craniofacial structures, which would be the main target of the preventive programs. Thus, 7-12-year-olds can benefit from preventive and interceptive oral health measures, which may totally either prevent or lessen the development of severe forms of malocclusions later in their lives.

AUTHOR’S CONTRIBUTION
This research work is part of a Master's thesis. The candidate is the first author (TAA) to conduct clinical work and thesis. Corresponding author (HAA), second author (KAA) and third author (MAA) supervised the work, revised and edited the thesis draft and the manuscript.

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CONFLICT OF INTEREST
No conflict of interest associated with this work.

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