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**Oral Health Behaviour and  
Compliance of Nigerian Adolescents  
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**Occlusal Relationships in the Primary  
Dentition of Senegalese aged 5-6  
years**

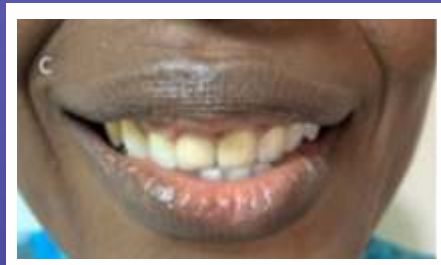


**Evidence-based Orthodontic Practice  
in Nigeria**



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**CASE REPORT**  
**Management of a Severe Gummy Smile  
with TADs**



# Intra-arch and Inter-arch Relationships in the Primary Dentition of Senegalese School Children aged 5-6 years

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**Background:** The aim of the present study was to investigate the features of the deciduous dentition in Senegalese school children aged 5-6 years.

**Methods:** Sociodemographic data were registered and from the dental casts of the children, parameters related to intra-arch and inter-arch relationships were collected (presence/absence of anthropoid spaces, molar and canine relationships, arch perimeter and width of the anthropoid and interincisal spaces in mm).

**Results:** The sample was made up 201 subjects (96 girls and 105 boys) with analysable study casts. With respect to intra-arch relationships, maxillary and mandibular anthropoid spaces are present in respectively 92.45 and 70.3% of the children. Regarding inter-arch relationships, flush terminal plane predominated followed by mesial step plane. The relationships between the upper and lower canine in the sagittal plane are mostly Class 1 (95%). As for the transverse plane, the majority of subjects (91.7% of the girls, 96.2% of the boys) has normal relationships ( $p = 0.24$ ). Almost half had a positive overjet  $> 2$ mm and reverse overjet accounted for 1 and 2% respectively for girls and boys.

**Conclusion:** The majority of subjects in this sample display intra-arch and inter-arch relationships favouring normal occlusal relationship of the permanent dentition.

**Keywords:** Senegalese children, intra-arch relationship, inter-arch relationship.

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**Keywords:** Primary dentition, occlusion, spacing, Terminal plane

## Introduction

Intra-arch and inter-arch relationships of the deciduous teeth have been studied extensively in both paedodontic and orthodontic literature<sup>1-7</sup>. A possible link between the occlusal features of the deciduous dentition and that of their subsequent permanent successors have been suggested early in

the 1900s by Bogue<sup>8</sup> and Chiavaro<sup>9</sup>. Specific occlusal traits in the primary dentition, predictive of good occlusal relationships in the permanent dentition have been emphasized. For instance, the presence in primary dentition of spaces mesial to the upper canines and distal to the lower canines referred to as Primate or Anthropoid spaces, was reported to be a predictor of good alignment of the permanent incisors<sup>10,11</sup>. Also, interincisal spaces also called secondary or developmental spaces are usually considered favourable to the uncrowded relationships of the permanent incisors. As for inter-arch relationships, the contacts between the deciduous second molars as objectified by the terminal planes determine at least in part, the sagittal relationship of the permanent first molar<sup>10</sup>. Epidemiological data on intra-arch and inter-arch relationships of adults and adolescents are available for many populations<sup>1,12-18</sup>. Also, studies have been published for different populations concerning intra-

arch and inter-arch relationship in the primary dentition<sup>2,19-28</sup>. Data concerning primary dentition of African children are however scarce. The aim of the present study was to investigate the features of the deciduous dentition in school children aged 5-6 years and to document the existence of potential anomalies.

### Materials and Methods

**Subjects:** As part of a comprehensive national epidemiological survey, this cross-sectional observational study was primarily directed towards children aged 5-6 years. At this age Senegalese children attend the first year of primary school with an average attendance rate of 80 %. Senegal is a developing country with a total area of 196,190 km<sup>2</sup> located at the western side of the African continent with a population estimated at 16,000,000.

The sampling design based upon the guidelines of the World Health Organisation (WHO) for Oral health survey was adapted to include 2 randomly chosen primary schools in the capital city, 2 in each of 2 different regional capitals and 2 in 3 areas<sup>29</sup>. In each site, 25 subjects were recruited randomly, which gave a total of 200 school children to be included in the study. To be sure that this number would be reached, 1 or 2 more children in each school were added to the previously programmed 25. The study protocol was approved by the local ethical committee and further validated by the health service authorities in each site.

Children were included when the following criteria were met: complete primary dentition with no permanent tooth, age between 5 to 6 years, and absence of caries and proximal restorations. In addition, prior to entry into the study, a consent form was given to the parents, guardian or caregiver explaining the nature of the investigation and requesting authorization to examine the children and take impressions of their teeth.

Alginate impressions of the maxillary and mandibular arches and wax bite registrations in centric occlusion were then obtained from each subject. The impressions were poured in white orthodontic stone, and the casts subsequently trimmed with the back horizontal to the occlusal plane. Study models with broken teeth or large voids were later excluded.

### Data collection procedure

The following variables were registered:

- 1) *Sociodemographic data* including age and gender were obtained directly from the children

and their parents and confirmed with the school registers.

- 2) *Intra-arch and inter-arch relationships of the maxillary and the mandibular teeth* were analysed using the study models. Linear measurements were registered using a digital caliper accurate to 0.01 mm (Mitutoyo Corporation, Tokyo, Japan) held parallel to the occlusal plane.

The following parameters were analysed:

- *Intra-arch relationship*
  - Primate or Anthropoid spaces were assessed dichotomously as present or missing
  - Arch perimeter was measured from the distal surface of second primary molar on one side, to the second primary molar on the other side
  - Width (mm) of the Primate or anthropoid spaces summed together
  - Width (mm) of interincisal spaces also known as Bogue's diastema
  - Total spaces including Primate's and Bogue's diastema and other spaces
- *Inter-arch relationships*
  - *Molar relationships*

In the sagittal plane, the maxillary and mandibular molar relationships were assessed using the terminal plane as described by Chapman.

**Flush terminal plane:** The distal surfaces of the upper and lower second primary molars in the same vertical plane in centric occlusion.

**Distal step plane:** The distal surfaces of the lower primary second molar in posterior relationship to the distal surface of the upper second molars in centric occlusion.

**Mesial step plane:** The distal surfaces of the lower primary second molar in anterior relationship to the distal surface of the upper second molars in centric occlusion.

**Crossbite** assessed dichotomously as present or absent. Crossbite is deemed to be present if a transverse relation of cusp to cusp or worse exists in the buccal segment

- *Canine relationships*

Canine relationships were assessed as 3 Classes equivalent to the Angle's classification for permanent canines.

**Class 1** The tip of the upper primary canine in the same vertical plane as the distal surface of the lower primary canine in centric occlusion.

**Class 2** The tip of the upper primary canine in anterior relationship to the distal surface of the lower primary

canine in centric occlusion.

*Class 3* The tip of the upper primary canine in posterior relationship to the distal surface of the lower primary canine in centric occlusion.

- *Incisor relationships*

Presence or absence of:

- anterior crossbite,
- Anterior open bite.
- Extent of the overjet
- Extent of the Overbite

All the aforementioned parameters were registered by the same examiner (BC) who underwent a calibration exercise after which kappa value of 0.85 to 1 for the qualitative variables and intraclass correlation coefficient (ICC) = 0.70 to 0.89 for linear measurements were reached.

### Data analysis

Qualitative variables were described as number and percentages. As for quantitative variables, their distributions, evaluated on the basis of skewness and kurtosis, were normal. Thus, central tendencies were described by means, and dispersion by standard deviations.

The chi-square test was used to analyse the intensity of the relationships, between qualitative variables. In the case of low frequencies, Fisher's exact test was computed.

Independent sample test was performed to search for any association between the dichotomized qualitative and the quantitative variables.

Statistical analyses were performed using SPSS "Statistical Package for Social Sciences" (SPSS 15.0.1 - November 2006). *P*-values less than 0.05 were interpreted as statistically significant.

### Results

In all, 201 children (96 girls and 105 boys) with analysable study cast were included in this study.

#### Intra-arch relationships

Maxillary and mandibular primate spaces were present in respectively 92.45 and 70.3% of the children. Regarding gender, more girls than boys lack Primate Spaces in both arches (Figure 1). Chi square test was used to compare the influence of gender on the presence of Primate Spaces. It showed a significant difference for the lower arch ( $p = 0.03$ )

but not for the upper arch ( $p = 0.42$ ).

The measurements of both arches' perimeter are displayed in Table 1.

The maxillary and mandibular arch perimeters are larger in boys than in girls, with a mean difference of 2.46 mm and 2.60 mm respectively for the upper and lower arch ( $p = 0.0001$ ).

The width of Primate Spaces ranged from 0 to 7.4 mm in the maxilla and 0 to 5.5 mm for the mandible. The Primate Space was larger in the maxilla than in the mandible but no sexual dimorphism was noticed ( $p = 0.68$  and 0.64 respectively for the maxilla and the mandible).

The amount of total space available in the arches ranged between -1.5 to 14.5 mm and -2 mm to 13.25 mm respectively for the maxilla and the mandible. Boys had larger spaces than girls (Table 1).

#### Inter-arch relationships

##### *Molar relationships*

Figure 2 displays the molar relationships in both the sagittal and transverse plane.

In the sagittal plane, flush terminal plane predominates followed by mesial step plane. No subject displayed distal step plane but 10.4 % of the girls and 12.4 % of the boys displayed asymmetrical terminal plane (mesial in 1 side and flush in the other side). No significant gender differences were noted regarding the terminal planes ( $p = 0.46$ ).

As for the transverse plane, the majority of subjects (91.7% of the girls and 96.2% of the boys) have normal relationships ( $p = 0.24$ ).

##### *Canine relationships*

The relationships between the upper and lower canine in the sagittal plane are mostly Class 1 (95%). Class 2 relationships are not found in Girls but are found in 1% of the boys. Asymmetrical relationships are found in 3.1 and 1.9 % of girls and boys respectively (Figure 3). There are no gender differences regarding canine relationships ( $p = 0.40$ ).

##### *Incisors relationships*

Almost half of the subjects had a positive overjet > 2mm. Edge to edge incisor relationships are found in 2.6 % of the subjects and reverse overjet accounted for 1 and 2% respectively for girls and boys (Figure 4).

**Table 1: Measurements of arch perimeters, primate spaces and total spaces for maxillary and mandibular arches in boys and girls of the sample**

	Gender	Minimum (mm)	Maximum (mm)	Mean (mm)	Standard deviation (mm)	Test t P value
Maxillary Arch perimeter	Boys	70.44	85.32	79.49	3.02	< 0.0001
	Girls	66.68	84.64	77.03	3.23	
Mandibular Arch perimeter	Boys	66.01	79.39	72.68	2.95	< 0.0001
	Girls	61.85	78.80	70.08	3.11	
Maxillary Primate Spaces	Boys	0.00	7.40	2.54	1.52	0.68
	Girls	0.00	7.00	2.45	1.65	
Mandibular Primate Spaces	Boys	0.00	5.50	1.30	1.22	0.34
	Girls	0.00	4.00	1.04	1.12	
Total maxillary Spaces	Boys	0.00	14.50	5.99	3.26	0.09
	Girls	1.50	12.69	5.55	3.39	
Total mandibular Spaces	Boys	1.52	13.25	3.77	3.20	0.12
	Girls	2.00	12.00	3.03	2.90	

**Table 2: Comparison of the maxillary intra-arch relationships found in this study with those published earlier.**

Authors/ year	No of subjects Gender/Age	Method of assessment	Arch perimeter	Interincisal diastema		Anthropoid spaces		Total spaces	
				(%)	(mm)	(%)	(mm)	(%)	(mm)
Otuyemi et al., 1997	294 boys 231 girls 3 to 4 years	Clinically from the patient	Not assessed	37.7	Not assessed	46.1	2.8	75.6	Not assessed
Warren et Bishara, 2001	59 boys 53 girls 4 to 5 years	On study casts	Boys : 72 Girls : 69.7	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Abu Alhaja et Qudeimat, 2003	48 boys 39 girls 5 to 6 years	On study casts	Boys: 73.7 Girls: 71.55	69.6	Not assessed	70	Not assessed	61.1	Not assessed
	1048 boys et girls 2 to 5 years	Clinically from the patient	Not assessed	69.6	Not assessed	70	Not assessed	61.1	Not assessed
This study	105 boys 96 girls 5 to 6 years	On study casts	Boys: 79.48 Girls: 77.03	Boys: 83.8 Girls: 78.1	Not assessed	Boys: 94.3 Girls: 90.6	Boys: 2.5 Girls: 2.4	Boys: 97.1 Girls: 95.8	Boys: 6 Girls: 5.5

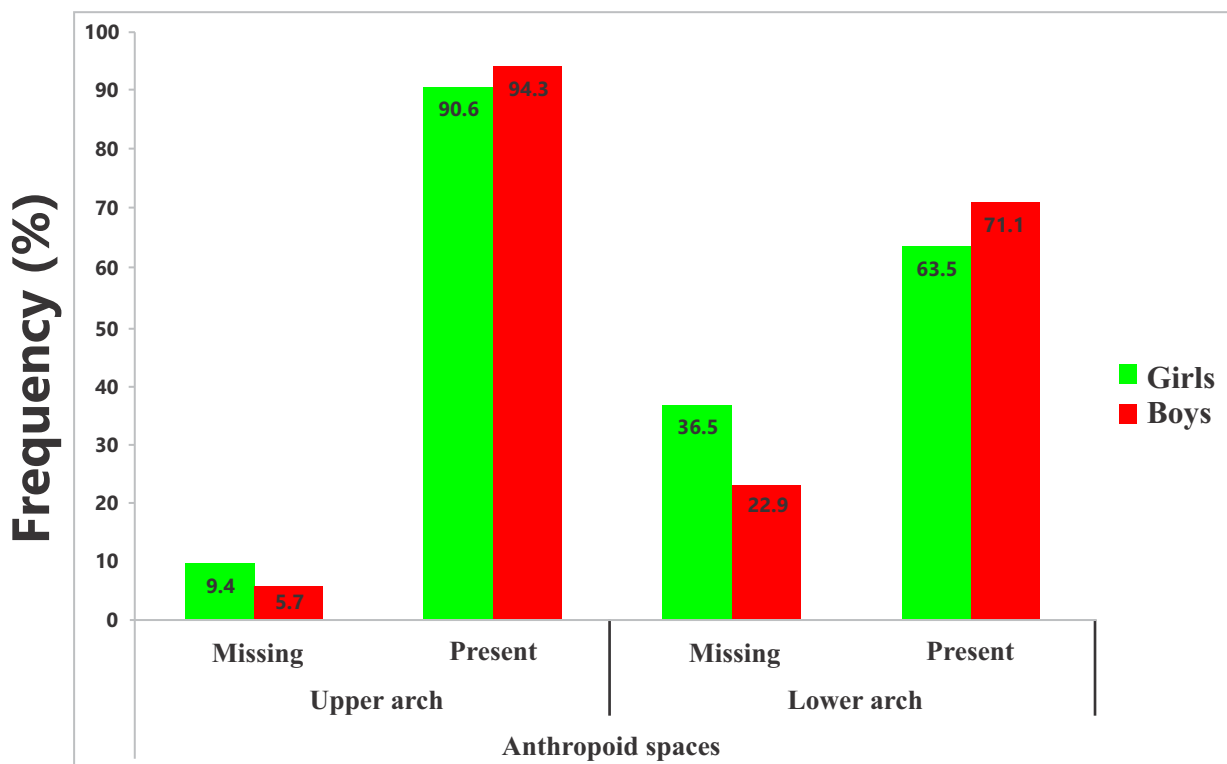
**Table 3: Comparison of the mandibular intra-arch relationships found in this study with those published earlier.**

Authors/ year	No of subjects Gender/Age	Method of assessment	Arch perimeter mm	Interincisal diastema		Anthropoid spaces		Total spaces	
				(%)	(mm)	Q(%)	(mm)	(%)	(mm)
Otuyemi et al., 1997 (37)	294 boys 231 girls 3 to 4 years	Clinically from the patient	Not assessed	44	Not assessed	56.8	Not assessed	75.6	Not assessed
Warren et Bishara, 2001 (43)	59 boys 53 girls 4 to 5 years	On study casts	Boys : 68.3 Girls : 64.4	Not asse- ssed	Not assessed	Not asse- ssed	Not assessed	Not asse- ssed	Not assessed
Abu Alhaja et Qudeimat, 2003 (2)	48 boys 39 girls 5 to 6 years	On study casts	Boys: 68.7 Girls: 65.39	Not asse- ssed	Not assessed	51.27	Boys: 2.3 Girls: 1.47	78.4	Not assessed
	1048 boys et girls 2 to 5 years	Clinically from the patient	Not assessed	69.6	Not assessed	51.27	Boys: 2.3 Girls: 1.47	78.4	Not assessed
This study	105 boys 96 girls 5 to 6 years	On study casts	Boys: 72.6 Girls: 70.07	Boys: 70.5 Girls: 70.07	Not assessed	Boys: 77.1 Girls: 63.5	Boys: 1.3 Girls: 1.03	Boys: 90.5 Girls: 82.7	Boys: 3.2 Girls: 3.03

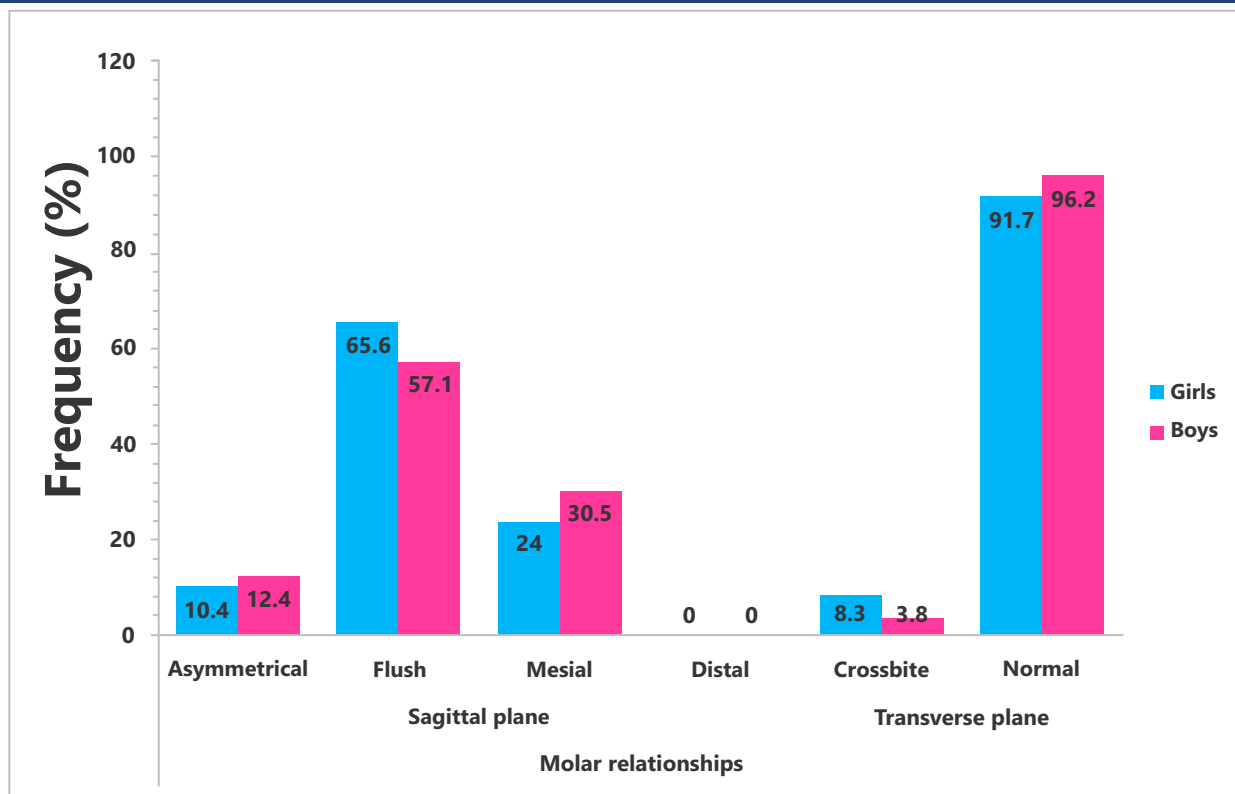
**Table 4: Comparison of inter-arch relationships found in this study with those published earlier.**

Author(s)/ year	Sagittal molar relationships	Sagittal canine relationships	Overjet
Baume (1950)	76% Flush terminal plane 14% Mesial step plane 10% Distal step plane	Not assessed	Not assessed
Farsi et Salama (1996) (19)	80% Flush terminal plane 12% Mesial step plane 8% Distal step plane	50% Class1 37.7% Class2 11.8% Class3	<b>76%:</b> 0<Overjet≤2mm 2.5%: Overjet>6mm 2% : Overjet<0
Otuyemi et al. (1997) (37)	75.5% Flush terminal plane 20.9% Mesial step plane 2.19% Asymmetrical 73.3% Class1	3 % Class2 11.7% Class3 8.8% Asymmetrical	68.8%: normal 14.7%: increased 9.7%: reduced 7%: negative
Abu Alhaja et Qudaimat, (2003) (2)	37% Flush terminal plane 47.7% Mesial step plane 3.7% Distal step plane 11.6% Asymmetrical	50% Class1 37.6% Class2 11% Class3	Not assessed
This study	61.1% Flush terminal plane 27.4% Mesial step plane 11.4% Asymmetrical	94.5 % Class1 0.5% Class2 2.5% Class3 2.5% Asymmetrical	Overjet<0 =3% Overjet =0 31.8% 0< Overjet <2 = 48.8% Overjet >2 = 16.4%

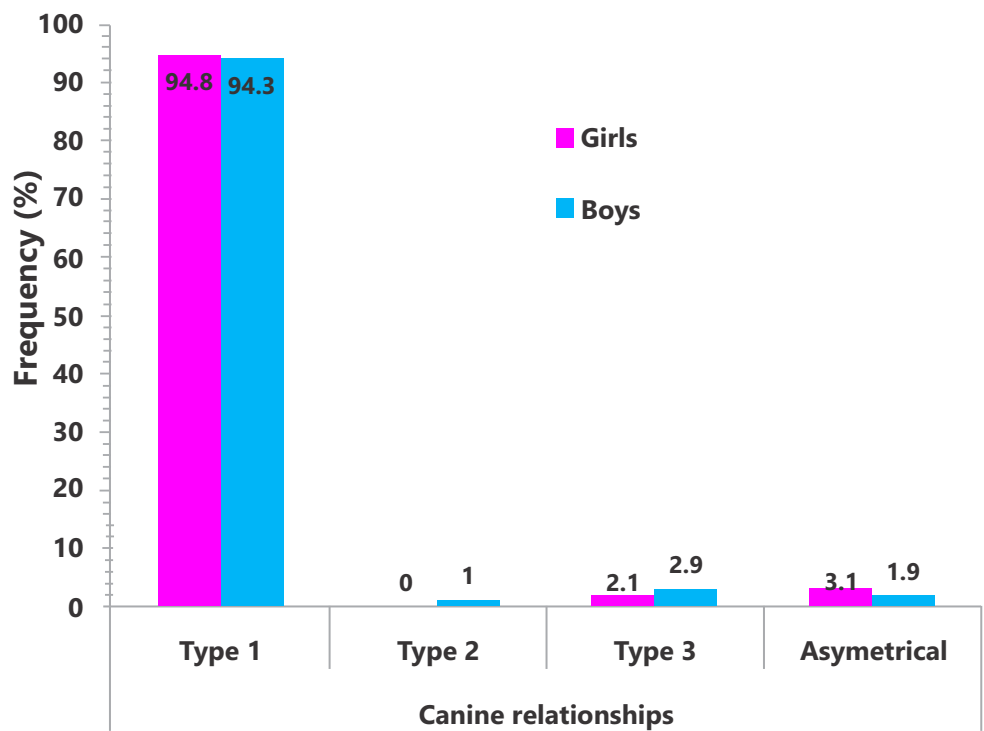
**Figure 1: Anthropoid/Primate spaces comparison based on gender**



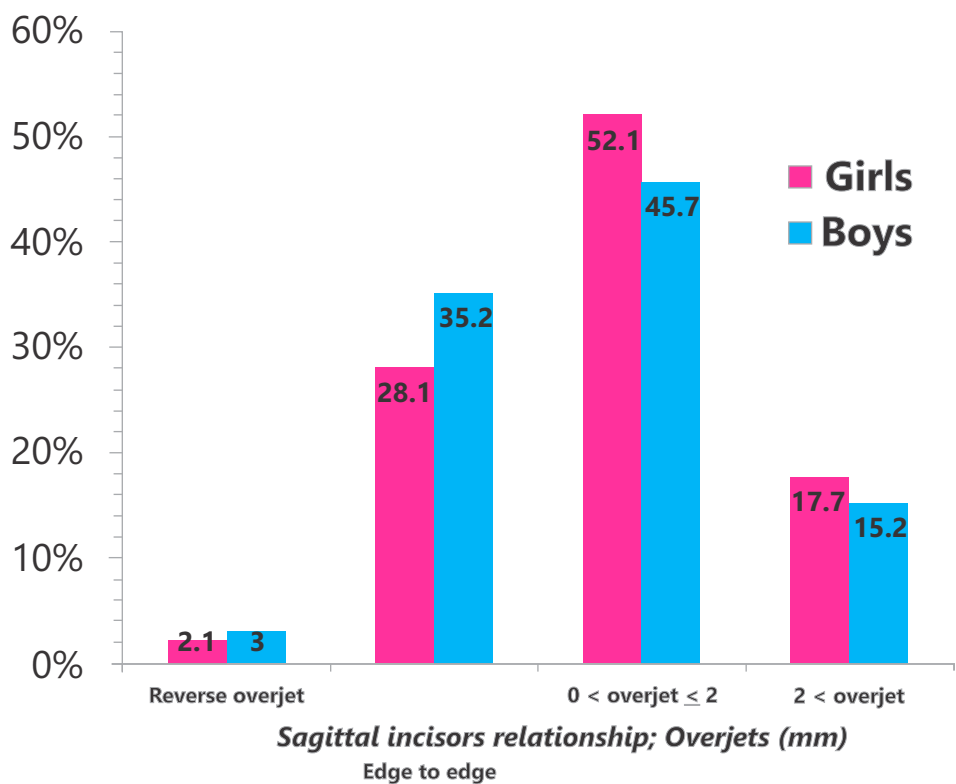
**Figure 2: Molar relationships in both the sagittal and transverse plane.**



**Figure 3: A comparison of canine and asymmetric relationships.**



**Figure 4: Sagittal incisal relationships**



## Discussion

Occlusal characteristics of primary dentition can be assessed clinically on the subject's dentition or on study casts obtained from the subjects. Both methods have their advantages and limitations. A direct examination allows inclusion of more subjects and is less expensive but might be less accurate. Information from study cast though more precise are costly and might not be suitable for large epidemiological surveys. In this study, the choice was made to favour the use of study casts in a relatively small but still representative sample.

Tables 2 to 4 display comparison of intra-arch and inter-arch relationships of primary dentition for 3 different ethnic groups as reported in former studies.

The Intra-arch relationships in this sample are characterized by the presence of anthropoid (primate) spaces in 92.45 and 70.3 % of the subjects respectively for the maxilla and the mandible. A smaller rate of anthropoid spaces was observed in Kenyan children aged 3 to 6 years (85%)<sup>30</sup>. Moreover, Abu Alhaija and Qudaimat (2003) reported a prevalence rate of 69.6 % for the maxilla and 51.2 % for the mandible among Jordanian children aged 4 to 5 years<sup>26</sup>. However, in the same study, these reached 70.8 % among children in the age bracket 5-6 years. Otuyemi and coworkers found in Nigerian children aged 3 to 4 years 46.1 % and 56.8 % of anthropoid spaces respectively for the upper and the lower arch<sup>27</sup>. In Caucasian children, Foster et al., reported anthropoid spaces in 70% of children 2.5 to 3 years old<sup>2</sup>.

These discrepancies may be related to the age differences among the different samples. In our study, the choice we made was to include only children aged 5/6 years without any permanent tooth. We assume that the characteristics of the primary dentition predictive of good occlusal relationships in the permanent dentition should be present at this age. Their absence might be regarded as some form of

abnormality.

Another reason accounting for the larger primate spaces in our sample may be their older age group.

With a mean of  $2.54 \pm 1.52$  mm for boys et  $2.45 \pm 1.65$  mm for girls, the maxillary anthropoid spaces are wider than the mandibular ones ( $1.30 \text{ mm} \pm 1.22$  and  $1.04 \text{ mm} \pm 1.12$  respectively for boys and girls).

Overall, it appears also that these spaces are larger in boys than in girls.

Concerning interincisal spaces also known as Bogue's diastema, their presence in 78.1% of girls and 83.8% of boys in the maxilla and 74% of girls and 70.5% of boys in the mandible might be considered as positive since they have been associated with lower incisor crowding. In comparison only 40% of children presented these spaces in another West African study<sup>27</sup>.

Regarding inter-arch relationships, the majority of children displayed a flush terminal plane which was found in 65.60 % of girls and 57.10 % of boys. Mesial terminal plane was found in 24 % and 30.5 % of girls and boys respectively while an asymmetrical terminal plane was seen in 10.4 of girls and 12.4 of boys. Distal terminal plane on both sides was not found in this sample. These results compare well with those reported in Nigerian (74,5 % for flush terminal plane) and Saudi Children (80 % flush terminal plane) but they depart from those reported by Kabue et al., 1995 in Kenyan ( 53% flush terminal plane, 43% mesial terminal plane and 1% for distal terminal plane), Abu Alhaija and Qudeimat in Jordanians (37% flush terminal plane, 47.7% mesial terminal plane and 1% for distal terminal plane) and Kisling (68%) in Danish children<sup>27,30,31</sup>.

Following a study in white, black and Apache Indian children, Infante suggested racial differences regarding inter-arch molar relationships with mesial terminal planes more frequently found in black than in white children<sup>32</sup>.

The upper and lower canine relationships were

predominantly of Class 1 (94.55 %). Class 3 accounted for 2.5 % and Class 2 for 1 %. Dissimilar distribution was reported by Farsi and Salama in Saudi children with Class 1 accounting for 86 %, Class 2 for 11 % and Class 3, 33%<sup>22</sup>.

With regard to sagittal incisors relationships, almost half of the children of both sex groups had an overjet ranging from 0 to 2 mm. Reverse overjet was found in 2.5 % of the surveyed children. These findings are in line with those reported by Abu Alhaija and Qudeimat with 50% of children in their sample displaying normal overjet<sup>26</sup>. However, they also found crossbite in 11.8% of the subjects. On the other hand, 76% of Saudi children aged 3-5years have been reported to have 0 to 2 mm<sup>22</sup>. In an African sample, normal overjet was retrieved in 68.6 % and reverse overjet in 7 %<sup>27</sup>.

Abnormal transverse molar relationships (crossbite) were found in only 2% of girls and 3% of boys in this sample. Comparable frequencies of crossbite were reported in Nigerian (4%) and Saudi children (4.8%)<sup>33,34</sup>.

In Caucasian however, a higher prevalence rate was reported. For instance Carvalho et al., in Belgian and Kerosuo et al., in Finnish children found respectively 10 and 13% of crossbite<sup>33,34</sup>.

Overall, occlusal traits in both intra-arch and inter-arch relationships, favourable to normal occlusion in the permanent dentition are mostly displayed in this

sample. This contrast highly with our findings in a former study of 42.6% of adolescent 12/13 years old needing orthodontic treatment according to dental health component of IOTN<sup>35</sup>

## Conclusion

Overall, occlusal traits in both intra-arch and inter-arch relationships, favourable to normal occlusion in the permanent dentition were mostly displayed in this sample. Significant gender differences were observed in the presence of primate spaces and in the arch perimeters. The girls recorded a significantly lower amount of primate spaces than the boys, while the boys recorded significantly larger maxillary and mandibular arch perimeters. The inter-arch relationships did exhibit any significant gender differences, with most of the participants exhibiting neutroclusion.

## Authors' Contributions

All the other authors contributed substantially to data collection, analysis, and write-up. All authors approved the final manuscript.

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## Conflict of Interest

None declared

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