

**RESEARCH ARTICLE****OCCLUSAL CHARACTERISTICS OF THE PRIMARY DENTITION AMONG A SAMPLE OF YEMENI PRE-SCHOOL CHILDREN****ABSTRACT**

The occlusal features change dynamically in the growing children and any disruption in the complex craniofacial growth process may lead to malocclusion, which is a major concern for the pediatric community because of its effects on dental function and beauty, as well as on the child's psyche. The aim of the present study was to study the prevalence of different occlusal traits in the primary dentition of the randomly selected pre-school children from three to five years in the city of Sana'a, Yemen. The study includes 1106 pre-school children subjected to a dental examination performed in the school premise, using the Foster and Hamilton criteria for occlusal traits. As well as inter- and intra-calibration tests were conducted for assessing the degree of agreeability. Results of the study showed that the Bilateral flush terminal molar relationship was found in 60%, bilateral mesial step in 27.9%, asymmetrical relationship in 8.5% and distal step in 3.5% of tested children. The Bilateral canine class I was detected in 62.8%, asymmetrical relationship (13.6%), class II (12.5%) and class III (11.1%). Normal over-jet (OJ) of 1-3 mm was identified in 39.2%, decreased OJ <1 mm (32.7%) and edge-to-edge (8.8%). Ideal over-bite (OB) of 1-50% was detected in 64.5% and increased OB of > 50% (19.7%). In conclusion the Bilateral flush terminal molar, class I canine relationships, normal overjet (OJ) of 1-3mm were the most commonly found sagittal occlusal traits in the current study. Ideal over-bite (OB) of 1-50% were identified in more than half of the children.

**KEYWORDS:** occlusal characteristics, primary dentition, pre-school children, Yemen

**INTRODUCTION**

Occlusal traits in the primary dentition are known to have an important bearing on the occlusal relationships in the secondary dentition<sup>1,2</sup>. Malocclusion is ranked third worldwide in dental public health second only to dental caries and periodontal disease<sup>3</sup>. The assessment of the occlusal traits of primary dentition will aid in the prediction of certain malocclusions such as; crowding, cross-bites, and anterior open-bites. This will enable an enhanced and effective preventive and interceptive measures to be constructed at an individual as well as in a larger scale level, all of which would ultimately reduce the degree of malocclusion in the permanent dentition<sup>1-3</sup>. Therefore, shorten the time taken and simplify the performance of comprehensive orthodontic treatment which can be reflected as a reduction in the psycho-social and monetary impact on the patient and patient's parents<sup>3</sup>. It is important to note that the difference in occlusal traits can be attributed to the differences in the criteria used to define them with differences in their interpretation<sup>4-6</sup>.

Numerous studies have been conducted on the occlusion in the primary dentition in children of different age groups in different regions of the world<sup>1-7</sup>. However, by comparison, few studies have been published in the Arab region. By reviewing these studies, one can conclude that the prevalence of different occlusal traits in primary dentition varies between different age groups, populations, and ethnicities around the world<sup>2-7</sup>.

As for Yemen, the only published study was directed towards the assessment of occlusal traits among the Yemeni adolescents using canine and incisor classifications<sup>8</sup>. However, no published study was found to reflect on the incidence of occlusal traits in the primary dentition of the Yemeni children. The objective of the current study is as follows: to assess the occlusion in sagittal, transverse and vertical planes namely: the terminal molar relations on the right and left side of the jaw, the primary canine relationship on the right and left side of the jaw, the over-jet (OJ) and over-bite (OB).

## SUBJECTS AND METHODS

This was a cross-sectional study conducted in six of the ten randomly selected administrative regions in Amanat Al Asimah, Sana'a City, Yemen. The target population of the study was preschool children aged 3 to 5 years, who attended a randomly selected public and private kindergartens, during the 2018-2019 school time period based on data collected from the Ministry of Education, Sana'a City, Yemen.

The sample size (n) required for this study was calculated to be 369 and this was through the utilization of the WHO formula for sample estimation which states that  $n = z^2 p (1-p) / e^2$ , where “n” represents the sample size. “p” as the expected prevalence of malocclusion. “z” as the standard score of 1.96 (95% CI: confidence level). e = maximum tolerable error 5%. For the purpose of increasing the significance level of the findings of this study the sample size was increased from 369 to 1106 pre-schoolers. To calculate the sample, the spread (P) was adopted by 60%<sup>3,9,10</sup>. In addition, a 1.5 (CF) correction factor was used to compensate the number of students who refused to participate in the study. The study sample (n = 1106) was determined through a two-stage sampling technique. In the first stage, a random sample was selected from several primary schools (public and private) from each of the six aforementioned provinces. It is followed by the second stage which involves random sampling of pupils from each of the aforementioned selected schools.

**The inclusion criteria:** Healthy Yemeni children. 3-5 years with primary dentition. Pre-school children whose parents / guardians agree.

**The exclusion criteria:** Those with a permanent first molar tooth erupting. Those who have missing teeth due to trauma, extraction, and tooth decay. Preschool children who have received interceptive and preventive orthodontic treatment.

Prior to collecting data, medical ethical approval was obtained from the Ethics and Research Committee at the University of Sana'a, followed by approval of education offices in the different administrative district to conduct this study in the schools assigned to them in their respective areas. Approval was obtained from school officials and parents of students who were randomly chosen through the school's mediator (principal or teacher) to explain the purposes of the study and the type of exam to be taken for their children. The child's permission was obtained before a dental examination. The examiner was trained and calibrated under the guidance of the supervisor at the Department of Pedodontics at the University of Sana'a to reduce the variability of the examiner during data collection. A total of 20 children were examined for both: the intra-examiner and inter-examiner reliability tests. The results were analysed statistically through the utilization of the Cohen's Kappa coefficient. The overall Kappa co-efficient for the inter-examiner and intra-examiner reliability shows a high level of agreement scoring 0.868 and 0.877 respectively.

The dental examination was carried out under natural daylight in the school premise. Disposable examination gloves and single use sterile mouth mirrors and explorer as well as sterile metallic mm rulers were made available for each child during the dental examination. Occlusion was assessed while each child was biting on his or her posterior teeth with the jaws in centric relation (maximal inter-cuspatation).

The criteria of Foster and Hamilton (1969) was used for defining the occlusion<sup>11</sup>. Occlusal norms were determined based on numerous studies found in the literature<sup>12-19</sup>. All of the examined students found to be suffering from malocclusion that would benefit from early interceptive paediatric or orthodontic dental treatment were referred to the paediatric dental clinic at the University of Sana'a, Faculty of Dentistry, to receive the required dental care.

## STATISTICAL ANALYSIS

The collected data was coded, inserted and analysed using IBM SPSS statistics for Windows, Version 21.0. Armonk, NY: IBM Corp, released 2012. The data were presented using tables, graphs, and pie charts. Basic standard descriptive statistics were calculated in the form of frequency and percentage to describe the qualitative variables. Pearson chi-square with Yate correction and Fisher tests were used to show the significance of the association between the outcome and its risk factors at a level of significance 0.05. P-value of less than 0.05 was considered as a statistically significant value. Odd ratio (OR) was calculated in addition to, the 95% confidence interval (CI).

## RESULTS

In this study, a bilateral dental examination was performed on a total number of 1106 children aged three to five years old. Figure 1 illustrates that; the Bilateral flush terminal molar relationship was found in 60% (664 out of 1106) of the pre-schoolers. Followed by: bilateral mesial step (27.9%), asymmetrical relationship (8.5%) and distal step (3.5%). Present in 309, 94 and 39 out of the 1106, respectively. Table 1 shows a significant correlation based on the Pearson's chi-square test between the different molar relationships distribution with the age and school type of the participants but no significant association was found with the gender of the study participants. Table 2 shows that the flush terminal was significantly associated with class I canine, normal OJ (of 1 – 3 mm sagittal overlap) and ideal OB (of 1 – 50% vertical overlap), where it was observed in 71.1%, 68.4% and 62.8%, correspondingly. The distal step molar relationship was most frequently seen in pre-schoolers with class II canine, increased OJ (of > 3mm) and increased OB (of > 50%), where 24.6%, 12.3% and 10.6% were affected, respectively. As for the mesial step molar relationship, it was found to be more commonly associated with class III canine (69.1%) and anterior reverse-bite (66.7%). The asymmetrical molar relationship was most frequently associated with the asymmetrical canine relationship and increased OJ of > 3mm and anterior open-bite, affecting 53.3%, 12.3% and 15.1%, in that order. The Bar chart illustrated in figure 2 shows that the Bilateral canine class I was detected in 62.8% of the study sample. Ensued by: asymmetrical relationship, class II and class III. Which were detected in 13.6%, 12.5% and 11.1%, respectively. However, as shown in table 3, no statistically significant affiliation between the distribution differences of the canine relationships with the age, gender, and school type of the study participants. The majority of the study sample (Figure 3 and table 4) possess normal OJ of 1-3 mm, which was identified in 39.2% (433 out of 1106) of the children followed by decreased OJ <1 mm (32.7% - 362 out of 1106), increased OJ of > 3 mm (16.9% - 187 out of 1106), edge-to-edge (8.8% - 97 out of 1106) and reverse-bite (2.4% - 27 out of 1106). But no significant association was found between the prevalence of different OJ relationships with the age, gender and school type of the pre-school study participants. Figure (4) shows that ideal OB of 1-50% was detected in 64.5% of the pre-schoolers. Followed by: increased OB of > 50% (19.7%), edge-to-edge (8.6%), anterior open-bite (4.8%) and reverse-bite (2.4%). With no significant correlation found between the distribution difference of the different OB relationships with the age, gender and school type of the study participants (table 5).

## DISCUSSION

In the current study, figure 1 shows that the majority of the pre-schoolers (60%) demonstrate a bilateral flush terminal molar relationship followed by the bilateral mesial step (27.9%).

These results coincide with other epidemiological studies conducted in countries such as Sudan <sup>20</sup>, Iraq <sup>21</sup>, Nigeria <sup>22</sup>, Saudi Arabia<sup>2, 23</sup>, India <sup>24</sup>, and Brazil <sup>25</sup>. However, it disagrees with the results obtained by Zhou *et al.* <sup>26</sup>, who observed that the prevalence of flush terminal and mesial step was similar among their Chinese pre-schoolers. As well as with Abu Alhaija and Qudeimat <sup>27</sup>, Chebet <sup>28</sup> and Baral *et al.*<sup>29</sup> who found out that mesial step was more commonly seen than the flush terminal molar relationship among their study participants. In the present study, a significant correlation was observed between the prevalence of different molar relationships and the age of the child as well as the type of their school. However, no significant association was observed between the occurrence of the molar relationship and gender (Table 1). These results were similar to what Yilmaz *et al.* have observed among their Turkish study participants <sup>30</sup>.

Table 2 shows that the flush terminal was significantly associated with class I canine relationship, where it was observed in 71.1%. These findings disagree with the Iranian study conducted by Sahebalam *et al.*, where class II canine occlusion seemed to have coincided with more than half of the flush terminal molar occlusions (62%) <sup>31</sup>. The asymmetrical molar relationship (figure 1) was the third common molar relationship, seen in 8.5%, which was greater than the results seen among the Kenyan, Indian and Sudanese pre-schoolers <sup>28, 20, 16</sup>. But, lesser than the Jordanian, Nepalese and Chinese studies <sup>27, 29, 26</sup>. The distal step (figure 1) was the least common type of molar relationship (3.5%), which was similar to the results seen among the Jordanian, and Saudi Arabian pre-schoolers <sup>27, 23</sup>. Furthermore, the distal step molar relationship observed in this study was most frequently associated with class II canine relationship (table 2). While, the mesial step among the study participants was more commonly associated with class III canine relationship (table 2). These results differ from those observed by Sahebalam *et al.*<sup>31</sup>, who discovered that class I canine relationship was largely associated with mesial step molars.

The Bilateral canine class I relationship was the most prevalent canine relationship in the current study, observed in 62.8% of the participants (figure 2). This result comes in agreement with the literature, where similar results were found among the Nigerian <sup>22</sup>, Jordanian <sup>27</sup>, Libyan <sup>34</sup>, Swedish <sup>35</sup> and Chinese <sup>26</sup> pre-schoolers retaining their primary teeth. However, the result was lower than studies conducted in India, Sudan, Iraq, Saudi Arabia, Turkey and Nepal, where the prevalence of class I canine relationship was in the 80 – 90 percentile <sup>30, 2, 36, 20, 29, 16, 37, 21</sup>. The asymmetrical canine relationship accounted for 13.6% (figure 2) which was similar to the study done by Abu Alhaija and Qudeimat on the Jordanian 3 to 5 year olds<sup>27</sup>. This was followed by: class II and class III canine relationships, which were observed in 12.5% and 11.1%, respectively. The class II relationship was found to be higher in prevalence among the Yemeni pre-schoolers in comparison to their Saudi <sup>2</sup> and Iraqi equivalents <sup>21</sup>. But, it was lower than the Jordanian <sup>27</sup> and Libyan <sup>34</sup> study participants. The prevalence rate of the canine class III in this study was close to the results obtained by Dimberg *et al.* in Sweden <sup>35</sup>, Zhou *et al.* in China <sup>26</sup> and Bahaduree *et al.* in India <sup>38</sup>. In Figure 3, a large proportion of the study participants (39.2%) had a regular OJ from 1 to 3 mm. Although this is consistent with other studies, where normal OJ was the most common OJ relationship. However, the rate on pre-school children in Yemen was lower than the rates in Saudi Arabia, Libya, India, Brazil, and Nigeria, which ranged between 47.5 - 89.5% <sup>22, 2, 6, 36, 34, 16</sup>.

The prevalence of the decreased OJ (less than 1 mm) was 32.7%, which was similar to what Hegde *et al.* has found among their Indian study participants. The edge-to-edge relationship was observed in 8.8% which was similar to the result obtained by Onyaso and Sote<sup>22</sup> in Nigeria. But, higher than the rates observed in India, Brazil, China and Libya <sup>6, 34, 16, 26</sup>. Ideal OB (of 1 to 50% vertical overlap) was detected in 64.5% of the current study subjects (figure

4). This result was similar to results seen in Iraq and Nigeria (both 67.3%)<sup>22, 21</sup>. But, higher than the results detected in Saudi Arabia, Kenya, Jordan and Libya<sup>27, 2, 28, 34</sup>. As for the edge-to-edge OB relationship, it was found to be present in 8.6% of the study participants, which was similar to the prevalence of edge-to-edge relationship in Saudi Arabia and Nigeria<sup>22, 2</sup>.

No significant relationship was found between the distribution difference of the different OJ (table 4) and OB relationships (table 5) with the age, gender and school type of this study participants, which was similar to the findings observed among the Libyan pre-schoolers, where Bugaighis did not find any significant correlation between the OJ with other factors such as: age and gender. As well as, a lack of correlation between the different OB recorded in this study and age. But regarding the lack of association between the different OB and gender, the results observed in this study comes in disagreement with the Libyan study, where the mean OB recorded in the Libyan boys was significantly greater than the girls<sup>34</sup>. Conversely, among the Saudi children, Zakirulla found out that the severity of OB was significantly less in the five-year-olds in comparison to the 3-year-olds<sup>23</sup>.

## CONCLUSION

In conclusion the Bilateral flush terminal molar, class I canine relationships, normal overjet (OJ) of 1-3mm were the most commonly found sagittal occlusal traits in the current study. Ideal over-bite (OB) of 1-50% were identified in more than half of the children.

## AUTHOR'S CONTRIBUTION

This research work is part of a Master's thesis. The candidate was the first author (LBY) has 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".

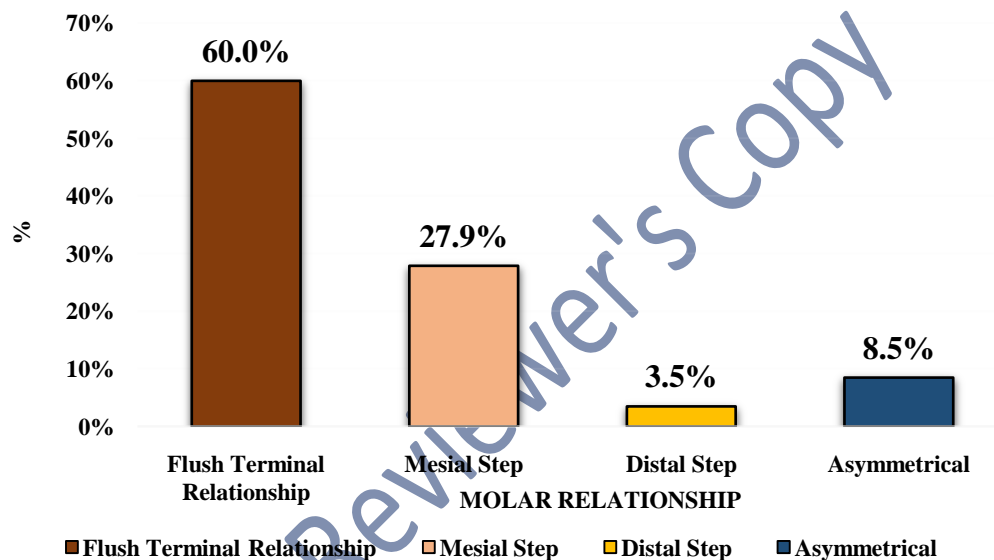
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**Figure 1:** Bar Chart Showing the Distribution of the Different Molar Relationships Among the Sample Population (n=1106).

**Table 1:** Explains the Distribution Differences of Different Molar Relationship According to Age, Gender and Type of School (n=1106).

Variables	Molar relationships								$\chi^2$	p-value*
	Flush terminal		Distal step		Mesial step		Asymmetrical			
	freq.	%	freq.	%	freq.	%	freq.	%		
<b>Age (year)</b>										
3 yrs. (n=109)	70	64.2	7	6.4	24	22.0	8	7.3	15.74	0.015
4 yrs.(n=308)	177	57.5	18	5.8	82	26.6	31	10.1		
5 yrs. (n=689)	417	60.5	14	2.0	203	29.5	55	8.0		
<b>Gender</b>										
Boy (n=589)	340	57.7	27	4.6	171	29.0	51	8.7	5.70	0.127
Girl (n=517)	324	62.7	12	2.3	138	26.7	43	8.3		
<b>School Type</b>										
Public School (n=370)	241	65.1	16	4.3	82	22.2	31	8.4	10.06	0.018
Private School (n=736)	423	57.5	23	3.1	227	30.8	63	8.6		
<b>Total</b>	664	60.0	39	3.5	309	27.9	94	8.5		

\*Based on Pearson's chi-square test ( $\chi^2$ ). Significant at p-value < 0.05.

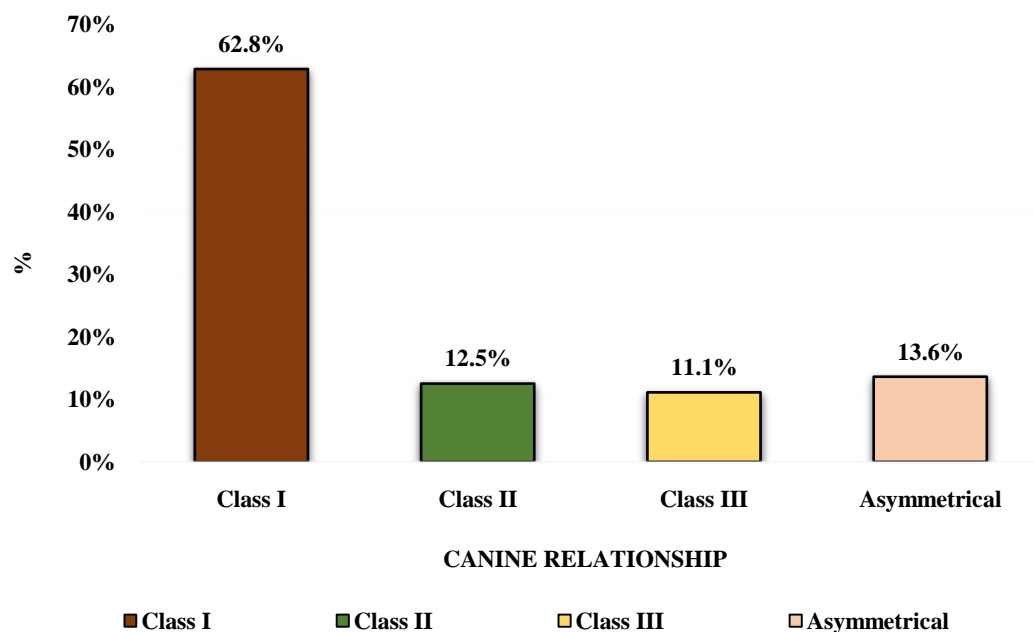


**Table 2:** Shows an Association Between Different Molar Relationships and Occlusal Traits such as: Different Canine Relationship, Incisor Relationship and Over-jet (n=1106).

\*Based on Pearson's chi-square test ( $\chi^2$ ). \*\* Based on Fisher's Exact Test. Significant at  $p$ -

VARIABLE	MOLAR RELATIONSHIPS										$\chi^2$	P-VALUE	
	Flush Terminal		Distal Step		Mesial Step		Asymmetrical		Total				
	freq. (664)	% (60)	freq. (39)	% (35)	freq. (309)	% (27.9)	freq. (945)	% (85)	freq. .	%			
<b>Canine Relationship</b>												756.27	<0.001*
I	494	71.1	4	0.6	186	26.8	11	1.6	695	62.8			
II	81	58.7	34	24.6	21	15.2	2	1.4	138	12.5			
III	37	30.1	0	0.0	85	69.1	1	0.8	123	11.1			
Asymmetrical	52	34.7	1	0.7	17	11.3	80	53.3	150	13.6			
<b>Over-jet</b>												118.91	<0.001*
Normal 3mm	296	68.4	7	1.6	90	20.8	40	9.2	433	39.2			
Increased >3mm	109	58.3	23	12.3	32	17.1	23	12.3	187	16.9			
Ant. Cross bite	7	25.9	0	0.0	18	66.7	2	7.4	27	2.4			
Decreased <1mm	205	56.6	9	2.5	123	34.0	25	6.9	362	32.7			
Edge-to-edge	47	48.5	0	0.0	46	47.4	4	4.1	97	8.8			
<b>Over-bite</b>												94.68	<0.001**
Ideal 1-50%	448	62.8	14	2.0	195	27.3	56	7.9	713	64.5			
Increase >50%	135	61.9	23	10.6	36	16.5	24	11.0	218	19.7			
Anterior open bite	29	54.7	2	3.8	14	26.4	8	15.1	53	4.8			
Edge to edge	45	47.4	0	0.0	46	48.4	4	4.2	95	8.6			
Reverse bite	7	25.9	0	0.0	18	66.7	2	7.4	27	2.4			
Decreased <1%	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0			

value < 0.05.

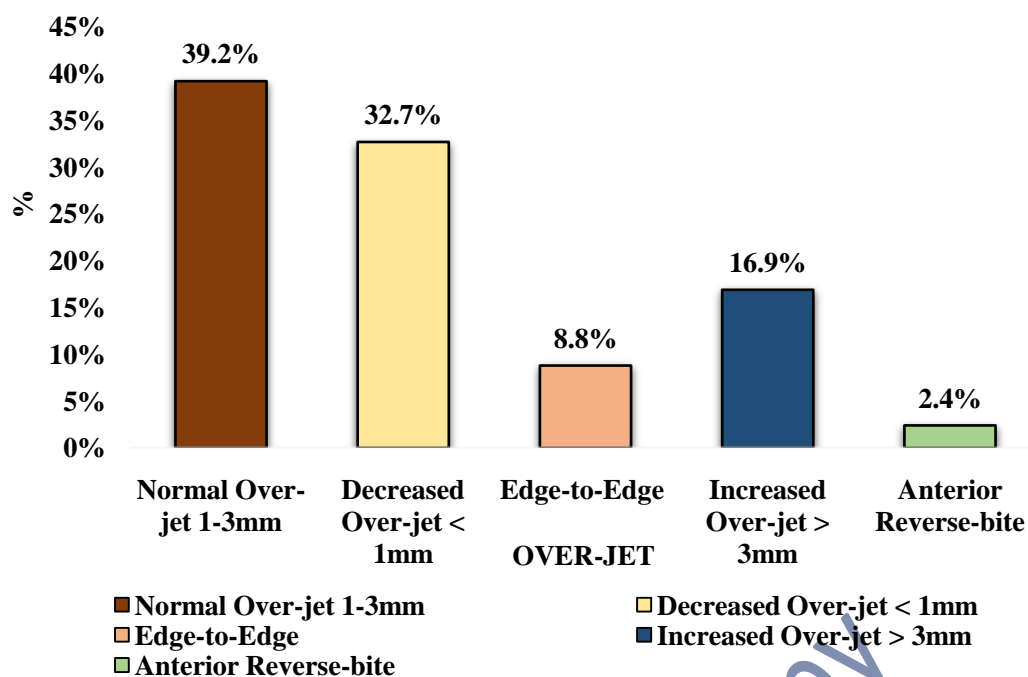


**Figure 2:** Bar Chart Showing the Prevalence of the Different Canine Relationships among the Study Participants (n=1106).

**Table 3:** Illustrates the Canine Relationship According to Age, Gender and Type of School (n=1106).

VARIABLES	CANINE RELATIONSHIPS								$\chi^2$	P-VALUE*
	I		II		III		Asymmetrica I			
	freq	%	freq	%	freq	%	freq.	%		
<b>Age (year)</b>										
3 yrs. (n=109)	64	58.7	17	15.6	15	13.8	13	11.9	2.34	0.886
4 yrs. (n=308)	193	62.7	38	12.3	34	11.0	43	14.0		
5 yrs. (n= 689)	438	63.6	83	12.0	74	10.7	94	13.6		
<b>Gender</b>										
Boys (n= 589)	366	62.1	73	12.4	67	11.4	83	14.1	0.44	0.932
Girls (n= 517)	329	63.6	65	12.6	56	10.8	67	13.0		
<b>Type of school</b>										
Public School (n=370)	232	62.7	46	12.4	41	11.1	51	13.8	0.02	0.999
Private School (n= 736)	463	62.9	92	12.5	82	11.1	99	13.5		
<b>Total</b>	695	62.8	138	12.5	123	11.1	150	13.6		

\*Based on Pearson's Chi-square test ( $\chi^2$ ). Significant at  $p$ -value < 0.05.



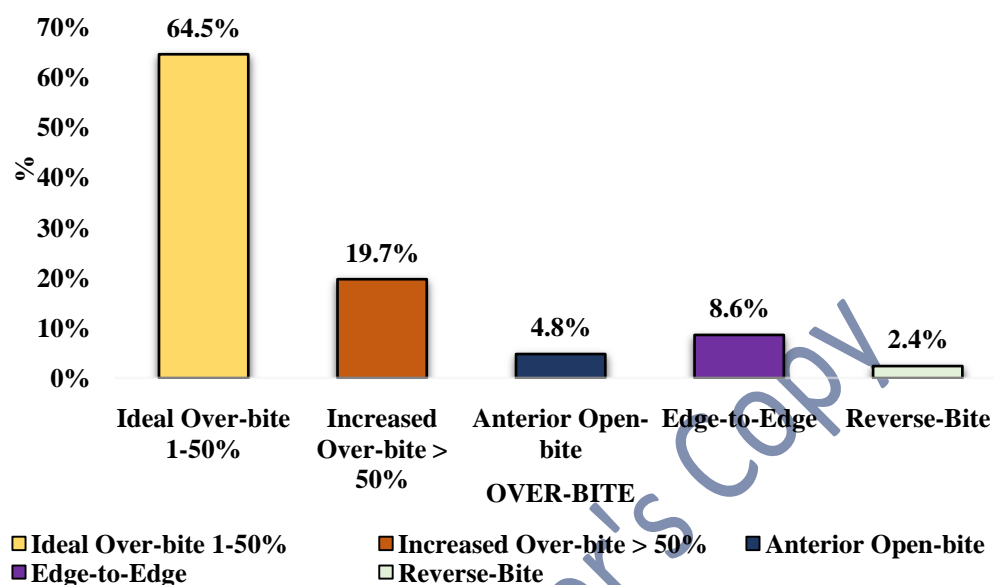
**Figure 3:** Bar Chart Illustrating the prevalence of the Different Over-Jet Relationships among the Sample Population (n = 1106).

**Table 4:** Explains the Distribution Difference in the Over - jet Relationships According to Age, Gender, and Type of School (n=1106).

Variables	Types of over-jets										$\chi^2$	p-value*	
	Normal 1-3mm		Increased >3mm		Reverse/Ant. Cross-bite		Decreased <1mm		Edge-to-edge				
	freq	%	freq	%	freq	%	freq	%	freq	%			
<b>Age (year)</b>												6.55	0.586
3 yrs.	42	38.5	24	22.0	3	2.8	33	30.3	7	6.4			
4 yrs.	127	41.2	56	18.2	7	2.3	96	31.2	22	7.1			
5 yrs.	264	38.3	107	15.5	17	2.5	233	33.8	68	9.9	4.11	0.391	
<b>Gender</b>													
Boys	228	38.7	107	18.2	10	1.7	193	32.8	51	8.7			
Girls	205	39.7	80	15.5	17	3.3	169	32.7	46	8.9			

Type of school											1.12	0.891
Public School	149	40.3	63	17.0	8	2.2	115	31.1	35	9.5		
Private School	284	38.6	124	16.8	19	2.6	247	33.6	62	8.4		
<b>Total</b>	<b>433</b>	<b>39.2</b>	<b>187</b>	<b>16.9</b>	<b>27</b>	<b>2.4</b>	<b>362</b>	<b>32.7</b>	<b>97</b>	<b>8.8</b>		

\*Based on Pearson's chi-square test ( $\chi^2$ ). Significant at  $p$ -value < 0.05.



**Figure 4:** Bar Chart Illustrating the Prevalence of the Different Over-Bite Relationship among the Sample Population (n = 1106).

**Table 5:** Shows the Distribution Difference of the Different types of Over-Bite Relationships According to Age, Gender and Type of School (n=1106).

\*Based on Pearson's chi-square test ( $\chi^2$ ). Significant at  $p$ -value  $< 0.05$ .

VARIABLES	OVER-BITE										$\chi^2$	P-VALUE*	
	Ideal 1-50%		Increase > 50%		Anterior Open bite		Edge to Edge		Reverse-bite				
	freq	%	freq	%	freq	%	freq	%	freq	%			
<b>Age (year)</b>												4.26	0.833
3 yrs.	73	67.0	22	20.2	4	3.7	7	6.4	3	2.8			
4 yrs.	201	65.3	59	19.2	19	6.2	22	7.1	7	2.3			
5 yrs.	439	63.7	137	19.9	30	4.4	66	9.6	17	2.5			
<b>Gender</b>												3.48	0.48
Boys	388	65.9	115	19.5	27	4.6	49	8.3	10	1.7			
Girls	325	62.9	103	19.9	26	5.0	46	8.9	17	3.3			
<b>Type of School</b>												2.41	0.661
Public School	240	64.9	75	20.3	13	3.5	34	9.2	8	2.2			
Private School	473	64.3	143	19.4	40	5.4	61	8.3	19	2.6			
<b>Total</b>	713	64.5	218	19.7	53	4.8	95	8.6	27	2.4			