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ORIGINAL RESEARCH

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Prevalence of malocclusion and oral health-related factors among pre-school children in Northern Albania

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Abstract

The aim of the present study was to investigate prevalence and association between malocclusion and caries among pre-school children aged 4–6 years frequenting public kindergartens in Shkodër, the largest city in North Albania. The sample for this descriptive and cross-sectional study included 389 pre-school children aged 4–6 years frequenting 20 public kindergartens in Shkodër, the largest city in North Albania. The participants were divided into two groups according to their caries experience evaluated, as determined by decayed-missing-filled index dmf (World Health Organization criteria) score. Those with dmf score of zero were considered to be free of caries. The prevalence of children with at least one malocclusion trait was 89%. The prevalence of caries was 66% (mean dmf score: 3.63). Increased overbite (43%), followed by increased overjet, were the most prevalent malocclusion traits observed in children with a dmf of zero. Among children with caries, the most prevalent trait was increased overjet (42%) and increased overbite. Almost half of the entire study population had a straight terminal plane and class I canine relationship. There was a similar prevalence of bilateral crossbite. Significant changes (p = 0.008) were observed between the groups with regards to the absence of spacing in the maxillary anterior region. Regression analysis further revealed that children with an absence of maxillary spacing were 2.564-fold more likely to have caries; those with a deepbite were 0.814-fold more likely to have caries. More than half of the children had caries. Increased overjet, overbite, crossbite and maxillary crowding were malocclusion traits observed in the population included in this study. A positive association was identified between maxillary crowding, deepbite and caries. The association between malocclusion and caries, highlights the necessity for an increased awareness of these two conditions that are commonly found among children of pre-school age.

Keywords

Malocclusion; Oral health; Preschool children; Prevalence

1. Introduction

Oral health in early childhood is an integral aspect of overall health and well-being. Malocclusion is also listed among the key factors affecting oral health and represents the most common health problem among children and adolescents [1]. The global prevalence of malocclusion is reported to be 54% from primary to permanent dentition [2].

Common traits of malocclusion in children of pre-school age, include an increased overjet (OVJ), overbite (OVB), open bite (OB), cross bite (CB), and space deficiency [3, 4]. Previous studies reported that malocclusions in the primary dentition are early signs of malocclusions in the permanent dentition [5]. Moreover, an increase in the prevalence of malocclusion from the primary to the mixed dentition may also occur [3]. Functional impairment and deleterious habits may develop during the first years of life; in particular, children in the pre-school stage (4–6 years-of-age) require careful monitoring [6]. Apart from being frequently identified in pre-school children [7], deleterious habits are etiological factors for certain malocclusion traits, such as increased OVJ, CB and anterior OB [8]. Hence, interceptive and early treatment alongside the establishment of normal growth and development will also reduce the need for orthodontic treatment in permanent dentition [9].

Dental caries is considered a common health problem in pre-school children and may affect the development of the permanent dentition [10]. Research has shown that the etiology of caries is multi-factorial, including the consumption of sugary drinks, malocclusion and poor oral habits [11].

Malocclusion and caries are considered to be common oral diseases. The existing literature does not appear to concur with the association between malocclusion and caries in the primary dentition. Certain malocclusion traits, such as space deficiency, either in maxillary or mandibular arches, deep bite

and distocclusion, have all been associated with an increased prevalence of dental caries [12–14]. In a previous study, Cho [15] suggested that the presence or absence of spacing should be included in the assessment tools used to determine the risk of caries. According to Zhang [10] and Stahl [16], caries is not an important factor in the most prevalent types of malocclusions in the primary dentition.

The importance of epidemiological studies in orthodontics is faced with the difficulties and limitations caused by the large number of indices and methods to determine occlusal traits [17]. An extensive literature review revealed that in addition to Angle classification, the Foster and Hamilton detailed description of primary dentition [18] criteria and Baume classification [19] were applied in studies among children with primary dentition [4, 8, 20, 21].

There is a significant lack of data related to malocclusion traits and associated factors in Albanian children of pre-school age, and the importance that health authorities, dentists and parents place on these issues. Thus, the aim of the present study was to investigate the prevalence and association between malocclusion and caries in pre-school children aged 4–6 years frequenting public kindergartens in Shkodër, the largest city in North Albania. We hypothesized that malocclusion is positively associated with caries.

2. Materials and methods

This descriptive and cross-sectional study, utilizing a convenience sampling method, aimed to determine the prevalence of malocclusion, caries and associated factors, in pre-school children in public kindergartens in Shkodër, the largest city of Northern Albania in April 2023. Approximately 1770 children aged 4–6 years attend 25 public kindergartens in this city. The sample size for this study was calculated using the formula $n = z^2\ p\ (1 - p)/e^2$, assuming a prevalence of 50% [22]. 385 was the minimum required sample size. Around 20 randomly selected kindergartens were selected to reach the necessary sample size of 389 children.

2.1 Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) Albanian ethnicity; (2) 4–6 years-of-age; (3) the absence of oral syndromes/clefts; (4) no history of orthodontic treatment, and (5) present on the day of examination and parental consent acquired. The exclusion criteria were as follows: (1) parent refusal to participate and (2) uncooperative children.

2.2 Study procedures

Examinations were performed by four dentists, each with a 15-year clinical working experience with the Public Dental Service for patients aged 0–18 years. The dentists were trained and calibrated by one of the authors (EK) who has practiced orthodontics since 2005 to reduce the inter-examiner variability during data collection. There was minimal disagreement between three of the examiners (with limited orthodontic experience) for certain occlusal traits; these were resolved by discussion with the author (EK) who did the training and calibration process. A total of 20 children were examined for both intra-examiner and inter-examiner reliability tests; this allowed calculation of Cohen's Kappa coefficient. The intra-examiner Kappa coefficient was 0.81 while the inter-examiner Kappa coefficient was 0.79; these were considered optimal.

In each kindergarten, dental examinations were carried out in rooms under natural daylight in total respect of infection control by using disposable examination gloves, sterile mouth mirrors and a sterile explorer. Occlusion was assessed while each child was biting on his or her posterior teeth with the jaws in centric relation (maximal inter-cuspation). Primary molar relationships were registered according to Foster and Hamilton, Baume [19] and Angle classification for primary canine. A periodontal probe (graduated to the nearest 0.5 mm) was used for all measurements. A series of occlusal traits were recorded, as described below.

Primary molar relationship: the relationship of the maxillary and mandibular second primary molars in the vertical plane.

Flush terminal plane: the distal surfaces of the upper and lower primary second molars were in one line with each other when the primary teeth were in occlusion.

Distal step: the distal surface of the lower primary second molar was distal to the distal surface of the primary upper second molar in occlusion.

Mesial step: The distal surface of the mandibular primary second molar was mesial to that of the maxillary primary second molar.

The primary canine relationship was defined as follows:

Class I: The cusp tip of the maxillary primary canine tooth was in the same vertical plane as the distal surface of the mandibular primary canine.

Class II: The cusp tip of the maxillary primary canine tooth was mesial to the distal surface of the mandibular primary canine.

Class III: The cusp tip of the maxillary primary canine tooth was distal to the distal surface of the mandibular primary canine.

Over jet (OVJ), expressed in (mm), was measured from the mid-point of the labial surface of the most anterior lower central incisor to the mid-point of the labial surface of the most anterior upper central incisor. OVJ was categorized as reverse (<0 mm), normal (1–2 mm), increased (>2 mm), and edge to edge (0 mm).

Overbite (OVB), expressed in mm, was measured as the vertical distance between the incisal edges of the upper and lower central incisors. OVB was categorized as open bite (OB), normal (1–2 mm), increased (>2 mm), and zero when the upper and lower incisal edges met edge-to-edge.

Spacing was recorded as being present when the child had spacing between all teeth in the anterior segments of the maxilla and mandible, and absent when there were not visible spaces or tooth rotation present.

Anterior cross bite (CB) was recorded as being present when one or more of the maxillary incisors/canine occluded lingually to the mandibular incisors/canines.

Posterior cross bite was recorded as being present when one or more of the maxillary molars occluded lingually to the mandibular molars.

Scissors bite was recorded as being present when the maxillary molars occluded to the buccal surfaces of the corresponding mandibular molars, and/or when the mandibular molars occluded to the lingual surfaces of the corresponding maxillary molars.

Midline deviation was recorded as being present when the mandibular midline deviated by 2 mm or more to the maxillary midline.

A child presenting with one of more occlusal parameters that deviated from the norm was recorded as having malocclusion.

Dental caries was diagnosed using the criteria and instruments (dental probe and mirror) recommended by the World Health Organization [23]. The participants were divided into two groups according to their caries status, as evaluated by dmf score (World Health Organization criteria). Children presenting with at least one decayed (d), filled (f) missing (m) dmf >0 was assigned to the caries group. There was no distinction according to the carious surface or severity. Patients with a dmf of zero were assigned to the caries-free group.

2.3 Statistical analysis

All calculations are made using IMB SPSS Statistics (Stat graphics Centurion 18: IBM Corp, NY, USA) and MS Excel. Basic standard descriptive statistics were calculated in the form of frequency and percentage for both groups. An independent sample *t* test was used to test differences between the means for the scale variables OVJ and OVB. The remaining variables were compared by Pearson's Chi-squared test. Binominal logistic regression was used to investigate the potential association between malocclusion and caries. The Wald test was used to determine the statistical significance of each independent variable. Variables with a p value < 0.05 were considered significant and were used to develop a predictive model. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.

3. Results

The total number of children involved in the present study was 389. Table 1 shows the comparative analysis of occlusal traits according to caries status.

3.1 Occlusal traits in the caries-free group

In total, 33.9% of the children examined presented with a dmf of zero. An increased OVB (mean ± SD; 3.92 ± 1.18 mm) was the most frequent malocclusion observed in 43% of the group. In contrast, 38% had an increased OVJ (3.93 ± 1.56 mm). An open bite was observed in 5% of patients (−1.5 ± 0.55 mm), 8% had an anterior CB, and 13.6% had a bilateral CB. A straight terminal plane was present in 48% of the children in this group.

3.2 Occlusal traits in the caries group

The prevalence of caries in the total sample was 66% (3.63 ± 4.11). Caries was more prevalent among mandibular deciduous molars (36.7%) and maxillary incisors (12.7%). The dominant malocclusion (42%) in this group was an increased OVJ (4.14 ± 1.11 mm). Increased OVB was observed in 37% of the children (3.76 ± 1.03 mm), open bite was observed in 6% of children, and bilateral CB was observed in 14% of the children. More than half of the children had a class I canine relationship and a straight terminal plane.

3.3 Inter-group comparisons

Compared to children with a dmf of zero (12%), there was a significantly higher number of children with caries (22%) with no spacing in the maxillary anterior region ($p = 0.008$). None of the other occlusal parameters showed any significant changes ($p > 0.05$).

The association between caries and malocclusion was evaluated by binomial logistic regression (Table 2). The model had a sensitivity of 92.5% with an overall predictive ability of 67%; this was considered a good level of prediction for caries.

A categorical variable maxillary crowding value (Exp = 2.564; CI: 1.054; 6.236) with both sides >1 indicated that as the predictor variable increased, so did the odds of having caries, although this was not statistically significant. In the case of the "OVB (mm)", variable, where Exp (B) = 0.814 < 1, both sides of the confidence interval were <1 (0.679; 0.975). Values that are <1 mean that as the predictor variable increases, so does the odds of having caries (with statistical significance).

4. Discussion

This study aimed to investigate the prevalence and association between malocclusion and caries in pre-school children frequenting public kindergartens in Shkodër, the largest city in North Albania. In total, 89% of the examined children had at least one malocclusion trait. A higher prevalence of malocclusion than other European children has been previously reported for Albanian children aged 7–15 years [22]. Our study indicated that an increased OVJ is common among preschool children, as described previously [7, 8]. Indeed, an increased OVJ in children in the caries group (42%) was not the most frequently found malocclusion trait for those children, but was higher than the observed frequency in the caries-free group. Stahl *et al*. [3] also reported that an increased OVJ was the most common malocclusion in deciduous dentition, as also observed in the present study.

It is well known and widely accepted that prolonged non-nutritive sucking habits and impaired function are etiological factors for open bite malocclusion [4, 10, 20]. Previous studies regarding the prevalence of open bite reported large variations from 4.6% [12] to 38.3% [20]. The open bite frequency in the present study was very similar between the two groups (5% *vs.* 6%). In a previous study, French and German children showed a reduction in the prevalence of open bite with increasing age [20, 24]. Our lower rate may have been influenced by the unequally distributed sample according to age.

There is now a strong body of evidence to suggest that non-nutritive sucking habits and impaired oral functionality are key etiological factors of CB [8, 9, 14], thus indicating the need for early treatment for CB (tscill24). In the present

TABLE 1. Occlusal traits and caries experience.

	Carries free dmf = 0			Carries present dmf >0		
	Frequency (n = 132)	Mean ± SD	*p* value	Frequency (n = 257)	Mean ± SD	*p* value
Sex						
Male	71 (54%)		0.182	139 (54%)		0.432
Female	61 (46%)			118 (46%)		
OVJ						
Normal	70 (53%)	1.70 ± 0.46		122 (47%)	1.74 ± 0.44	
Increased	50 (38%)	3.93 ± 1.56	0.375	107 (42%)	4.14 ± 1.11	0.472
Decreased	4 (3%)	−1.50 ± 0.58		8 (3%)	1.88 ± 0.64	
0 mm	8 (6%)	0		20 (8%)	0	
OVB						
Normal	60 (45%)	1.55 ± 0.50		127 (49%)	1.53 ± 0.50	
Increased	57 (43%)	3.92 ± 1.18	0.275	96 (37%)	3.76 ± 1.03	0.329
Open Bite	6 (5%)	−1.50 ± 0.55		15 (6%)	−1.60 ± 0.51	
Edge to Edge	9 (7%)	0		19 (7%)	0	
Anterior CB						
Present	11 (8%)		0.379	25 (10%)		0.521
Absent	121 (92%)			232 (90%)		
Posterior CB						
Uni present	16 (12%)			21 (8%)		
Absent	116 (87.80%)		0.324	236 (82.80%)		0.342
Bi present	18 (13.60%)			36 (14%)		
Absent	114 (86%)			221 (86%)		
Midline						
Centered	92 (70%)		0.126	165 (64%)		0.412
Deviated	32 (24%)			81 (32%)		
Canine Relationship						
Left side						
Class I	79 (60%)			163 (63%)		
Class II	34 (26%)		0.235	71 (28%)		0.319
Class III	19 (14%)			23 (9%)		
Right side						
Class I	84 (64%)			167 (65%)		
Class II	32 (24%)		0.324	56 (22%)		0.527
Class III	16 (12%)			34 (13%)		
Molar relationship						
Left side						
Straight	64 (48%)			131 (51%)		
Mesial	24 (18%)		0.247	43 (17%)		0.418
Distal	44 (33%)			82 (32%)		
Right side						
Straight	64 (48%)			139 (54%)		
Mesial	23 (17%)		0.327	46 (18%)		0.478
Distal	44 (33%)			71 (28%)		
Spacing						
Maxilla						
Present	114 (86%)		0.174	199 (77%)		0.458
Absent	16 (12%)			57 (22%)		
Mandible						
Present	92 (70%)		0.185	159 (62%)		0.432
Absent	22 (17%)			56 (22%)		

**p value < 0.05 statistically significant. OVJ: overjet; OVB: overbite; CB: cross bite; SD: standard deviation; dmf: decayed-missing-filled.*

TABLE 2. Binomial logistic regression results.

	B	S.E.	Wald	Sig.	Exp (B)	95% CI for Exp (B)	
						Lower	Upper
OVB (mm)	−0.206	0.092	4.984	0.026*	0.814	0.679	0.975
Ant CB	−0.114	0.558	0.041	0.839	0.893	0.299	2.665
Crowding Max	0.942	0.453	4.313	0.038*	2.564	1.054	6.236
Crowding Mand	−0.303	0.394	0.593	0.441	0.738	0.341	1.598
Post CB	0.100	0.282	0.125	0.723	1.105	0.635	1.922
Left canine relationship			3.468	0.177			
Class 1	0.085	0.354	0.058	0.810	1.089	0.544	2.179
Class 2	−1.633	0.891	3.358	0.067	0.195	0.034	1.120
Right canine relationship			0.671	0.715			
Class 1	−0.105	0.367	0.081	0.775	0.901	0.439	1.847
Class 2	0.567	0.767	0.548	0.459	1.764	0.393	7.924
Left molar relationship			0.084	0.959			
Straight	0.065	0.441	0.021	0.883	1.067	0.449	2.533
Mesial	0.096	0.346	0.076	0.782	1.100	0.559	2.167
Distal	−0.665	0.407	2.667	0.102	0.514	0.232	1.142
Right molar relationship			1.874	0.392			
Straight	0.307	0.511	0.360	0.548	1.359	0.499	3.696
Mesial	−0.372	0.341	1.187	0.276	0.690	0.353	1.346
Distal	−0.079	0.375	0.044	0.834	0.924	0.443	1.930
Midline deviation	0.372	0.283	1.733	0.188	1.451	0.834	2.524
Constant	0.862	1.272	0.459	0.498	2.368		

*OVB: Overbite; Ant CB: Anterior cross bite; Post CBP: posterior cross bite; CI: confidence intervals; S.E.: standard error. *p value < 0.05 statistically significant.*

study, the prevalence of anterior CB varied from 8% in the caries-free group to 10% in the caries group. The reported prevalence of cross bite in the present study is in line with previous studies reporting prevalences of 7.5% [1], 10.1% [19] and 17.8% [25]. A similar frequency was detected among the two groups for bilateral CB (13.6 and 14%). Furthermore, unilateral CB was more frequent (12%) in children who had caries-free dentition. In a previous study, unilateral CB was the most frequent malocclusion observed in a sample in which almost half of the children had tongue thrust and exhibited mouth breathing [7].

In the present study, the majority of children had primary second molars in a straight terminal plane and a class I canine relationship; this was in agreement with previous reports involving Greek and Lithuanian children [4, 21]. Comparing distal and mesial step frequency in our sample showed that distal step was more frequent than mesial step. A previous study reported that distal step was significantly associated with oral habits in Nepalese pre-school children [9]. A similar frequency of canine class III relationship was also reported in 538 Chinese preschool children [10]. In these circumstances, our results suggest that there is a high tendency for malocclusion in Albanian preschool children. Considering the absence of data regarding the prevalence and characteristics of class III malocclusion in the Albanian population [26], this finding could be partially supported from the previous results of a study of Croatians. Interestingly, this earlier study related a high prevalence of class III malocclusion in the European Caucasian ancestry with a "Habsburg jaw" [27].

At present, a reduced prevalence of caries is being reported in industrialized countries; however, the prevention of caries in the initial phase still needs to improve [28]. In total, 60% of the children included in our present study had at least one carious tooth. The actual prevalence of caries in our study of Albanian children was lower than that of a previous study (84.1%) reported by Hysi *et al.* [29]. The most plausible explanation for the lower prevalence in our study seems to be related more to the protocol applied and the fact that Hysi *et al.* [29] reported the prevalence of caries country-wide. Hysi *et al.* [29] reported that children from North Albania had a higher prevalence of caries than children living in West and Central Albania, the region hosting the capital Tirana, where most of the dentists work and patients have better access to a wide range of treatment options.

Apart from the high prevalence of crowding over the last few decades [24], studies have also found that crowding in the primary dentition is the most prevalent form of malocclusion [14]. It is difficult to compare the crowding frequency observed in the present study with previous similar studies due to the variety of protocols applied. Hence, regardless

of the large variation observed with regards to crowding of the primary dentition, the affected children are more likely to experience crowding in the permanent dentition [1]. In the present study, crowding was significantly more frequent in the maxillary anterior region in children from the caries group. In agreement with previous research [12, 13], we also found an association between crowding and dental caries. Indeed, regression analysis revealed that children with an absence of maxillary spacing are 2.564-fold more likely to have caries.

Deep bite is a frequently observed malocclusion among preschool children [30], and has a tendency to increase from deciduous to the mixed dentition. Moreover, a previous study reported that this deep bite does not show a self-corrective tendency and may deteriorate [16]. Results from the present study showed that an increased deepbite was more frequent in the caries-free group. However, our regression analysis found that children with a deep bite were 0.814-foldmore likely to have caries. Our results are in disagreement with the previously reported association between caries and deepbite malocclusion [13, 30]. The first reason for this disagreement relates to the protocol used in the present study which was different with those used in previous studies. Secondly, in the present study, caries was more prevalent in mandibular molars whereas among Chinese children, Lin *et al*. [30] attributed the low prevalence of deep bite to caries in the anterior maxillary teeth. Interestingly, Lin *et al*. [30] also reported a higher prevalence of deep overbite in children with lip-biting habits.

This study has some limitations that need to be considered. Due to the absence of previous data regarding Albanian pre-school children, we were unable to use a methodological protocol that has been validated for epidemiological studies in orthodontics [31]. In addition, caries was not recorded and classified according to severity, including pulp involvement due to inability, and medico-legal issues preventing radiological examinations in epidemiological studies. Another limitation of the present study is related to the fact that we did not consider factors such as fluoride implementation, corticosteroid medications, mouth breathing, or conditions such as asthma that are known to influence the presence of carious cavities. The children who participated in this study were from one city; therefore, the reported prevalence and malocclusion traits cannot represent all Albanian pre-school children.

Even though other studies [30] reported poor correlations between the prevalence of oral habits measured from questionnaires completed by parents and from clinical examination, in the present study, we did not assess oral habits and impaired function.

Despite these limitations, and our recommendations for caution when interpreting our results, this is the first study to report the prevalence of malocclusion traits among Albanian pre-school children; our results represent a valuable reference for future studies.

5. Conclusions

More than half of the children included in this study had caries. Malocclusion traits observed were increased OVJ, OVB, anterior CB, posterior CB, midline deviation and crowding. The prevalence of class III canine relationships was also high. Children with an absence of maxillary spacing and a deep OVB were more likely to have caries. The association between malocclusion and caries status, highlights the necessity for an increased awareness towards these two conditions that are commonly found in children of pre-school age. Although we did not evaluate oral habits and function, the high prevalence of certain malocclusion traits that are associated with deleterious habits, non-nutritive sucking habits, and oral breathing, suggest that they are also widespread in pre-school children in Albania. However, this should be verified with more detailed studies including data obtained from the parents.

AVAILABILITY OF DATA AND MATERIALS

Data available upon request to corresponding author.

AUTHOR CONTRIBUTIONS

EK and GMG—designed the research study. EK—performed the research. ES and IG—analyzed the data. EK, IG and ES—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Albanian University (protocol code 239 and date of approval 27 March 2023). All parents received a consent form which had to be signed prior to examination.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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