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Original Article

Prevalence and risk indicators of primary dentition malocclusion in Riyadh-Saudi Arabia using a new case definition: A cross-sectional study

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ABSTRACT

Objectives: To determine the prevalence of primary dentition malocclusion and its linked risk indicators among a group of Saudi preschool children.
Methods: A cross-sectional study was carried out on preschool children aged 3 to 5 years residing in Riyadh City, the capital of Saudi Arabia. The study sample included 709 Saudi children of both genders with complete primary dentition. Oral examination was conducted for children to assess the anteroposterior, transverse, and vertical dimensions, arch spacings, and oral habits.
Results: The prevalence of malocclusion was 59.1% among the study participants. A deep overbite and increased overjet were found in 26.23 % and 25.11%, respectively. Arch space problems were reported, including missing primate spaces in 24.12%, missing developmental spacing in 27.93%, and crowding in 14.1%. An association between mothers aged 25 years and younger at childbirth was linked with their child's malocclusion in the primary dentition (p-value of 0.03).
Conclusion: The prevalence of primary dentition malocclusion among a specific group of Saudi preschool children was significantly high. Increased overbite and overjet were the most prevalent occlusal discrepancies, followed by arch spacing problems. The younger mother's age at childbirth is significantly associated with her child's malocclusion. The study results can serve as a baseline for future investigations.

1. Introduction

Malocclusion is defined as any misalignment or mal-relationship between the dental arches, with or without associated irregularities of the teeth (Gupta et al., 2016). Malocclusion can potentially lead to a deficiency in chewing, speech, articulation, and undesirable development of craniofacial bones (English et al., 2002). Proper alignment of teeth in children has a strong positive impact on their quality of life as well as their social interaction skills (Bishara et al., 1995; De Oliveira & Sheiham, 2004). There is an increased awareness of the close association and role of the primary occlusal relationship to the permanent tooth alignment and occlusal features (Khan R, Singh N, Govil S, 2014). Previous studies have proven that the presence of malocclusion in primary dentition will eventually lead to malocclusion in its successor (Onyeaso & Isiekwe, 2008; Peres et al., 2015). Moreover, malocclusion in the deciduous dentition is considered a risk factor indicating the necessity of orthodontic treatment in the future. Therefore, it is important to closely monitor the occlusion in children and initiate immediate intervention at an appropriate time when required (Bishara et al., 1988). Although characteristics of primary occlusion have been well addressed in the literature by different authors, it is known that different population groups and ethnic backgrounds can influence the development of the

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occlusion (Lauc, 2003). Genetic and environmental factors have also been shown to strongly influence the development of either normal or abnormal occlusion (Bishara et al., 1988).

Dental literature lacks a consensus on the case definition of malocclusion in primary dentition, leading to the absence of an appropriate index to measure its prevalence. Limited epidemiological data on Riyadh's population prompted this study to determine malocclusion prevalence in primary dentition and its risk indicators among Saudi preschool children, using a proposed definition focusing on abnormalities rather than normative occlusion.

2. Materials and methods

A cross-sectional study was conducted in Riyadh City, Saudi Arabia, on preschool children aged 3 to 5 years. Ethical clearance was obtained from the Princess Nourah bint Abdulrahman University Institutional Review Board (**IRB: 180240**). The required sample size of 683 participants was calculated based on an estimated 8.1% malocclusion prevalence from a prior study by Farsi and Salama in 1996 (Farsi and Salama, 1996), with a 95% confidence interval and 3% margin of error.

A convenience sample of kindergarten children from nine selected schools, covering different regions in Riyadh city, was used to ensure representation. Written permission from the school authorities was obtained before conducting visits. The final sample included 709 Saudi children of both genders with complete primary dentition, whose parents provided consent for participation. We excluded children with systemic diseases/syndromes, developmental tooth anomalies, extensive caries, premature tooth loss, or erupted permanent teeth.

2.1. Data collection

The data collection for this study involved a two-step process. Initially, a self-administered questionnaire was provided to the child's mother, and subsequently, a clinical examination was conducted to assess the child's occlusion. Informed consent, along with the questionnaire, was sent to the child's mother well in advance of the examination visit. On the examination day, only those children who met the inclusion criteria, provided signed informed consent, and completed the questionnaire were subjected to the occlusal examination.

The questionnaire was structured based on a design by Zhou et al. (Zhou et al., 2016) and was modified to suit the study's objectives. It consisted of three main sections:

- Demographic data of the mother, including age, education level, and family income.
- Characteristics of the child, such as age, sex, natal and family history, and feeding methods.
- History of previous or persisting deleterious oral habits, such as digit/pacifier sucking, lip habit, tongue thrusting, mouth breathing, and bruxism (Nowak, 2000)

Before the fieldwork, three examiners (AA, AG, and AH) underwent training and calibration under the guidance of an expert examiner to ensure consistency and agreement on the diagnostic criteria. Inter- and intra-examiner reliability was assessed using Kappa Statistics, resulting in kappa statistics inter-rater = 0.80 and kappa statistics intra-rater = 0.89, indicating good agreement.

A pilot study was conducted on ten children aged 3 to 5 years in the dental clinics of our university to ensure the smooth running of the main study. Data from the pilot study was not included in the main analysis but was used to modify the questionnaire and examination form.

The clinical examination adhered to WHO standards for infection control (World Health Organization, 2013). Disposable mirrors, tongue depressors, gauze, cotton rolls, and printed rulers were used during the examination. Each child was seated on a chair with the aid of a headlight under natural light to evaluate occlusion when teeth were in centric occlusion. The examination forms were designed to record various parameters in three spatial planes. The assessment of anteroposterior dimension, transverse relationship, vertical dimension, and alignment were summarized in **Supplementary file 1**.

2.2. Assessment of malocclusion

Since there is a lack of a standardized comprehensive index to assess malocclusion in the primary dentition, children displaying any deviation from normal occlusion defined by (Bishara et al., 1995) were considered as having malocclusion. Thus, malocclusion was recorded when one or more of the following traits were observed; distal step, increased overjet $\geq$ 4 mm, anterior crossbite, deep overbite greater than 50%, anterior open bite, posterior crossbite or crowding, in addition to class II and III canine relationships based on the findings of Peres et al. (Peres et al., 2015).

2.3. Statistical analysis

Frequencies and percentages were calculated for all variables. Comparisons by gender, type of school, and malocclusion status were conducted using Chi-square or Fisher exact tests. Binary logistic regression was used to assess the effect of different factors on the malocclusion. The model was adjusted for potential confounders (child age, socio-economic status, and school type). Odds ratios and 95% confidence intervals were calculated. Significance was set at P value $<$ 0.05. Data were analyzed using SPSS statistical software version 23.

3. Results

Most children were greater than 4 years old (88.72%), females (50.63%), from private schools (62.06%), and were born full-term (95.06%). Most mothers were aged 20–35 years old (53.17%), 26–34 years of age at childbirth (54.73%), and with a bachelor's or higher degree (84.06%), as shown in Table 1.

Supplementary Table 1 showed that 58.53% of children were on mixed feeding, and about half of them used a pacifier. The most common oral habits reported were bruxism (12.13%) and mouth breathing (8.32%). However, most of the parents (67.84%) were not aware their child was practicing oral habits, and 51.48% reported a family history of malocclusion or tooth abnormalities.

Most parents did not think their child had malocclusion (57.40%). However, when cross-classifying the parents' awareness with the true status of malocclusion, the results show no statistical significance (P = 0.63).

Supplementary Table 2 reveals that the mesial step was the most common terminal plane (55.01%), followed by the flush plane (42.03%). The most frequent canine relationship was class I (83.22%), followed by class II (9.59%) and class III (7.19%). Normal overjet and overbite represented more than 68% of the sample compared to 25.11% of participants with increased overjet and 26.23% with a deep overbite. Midline deviation was mostly observed in the mandible (15.23%). Unilateral lingual crossbite was more frequent than other types of crossbite. Overall, there were no significant differences between males and females across all occlusal characteristics.

Fig. 1 shows that 24.12% had missing primate spaces (18.76% in the maxilla and 22.85% in the mandible), 27.93% had missing developmental spacings, and crowding was noted in 14.10% of the subjects with no statistically significant differences between the sexes.

Fig. 2 indicates that 11.14% of the subjects had persistent oral habits, with bruxism as the most frequent habit (6.91%), followed by mouth breathing (2.12%). There was no statistically significant difference between male and female participants (P = 0.47). When the frequency distribution of persistent oral habits was investigated according to school type (i.e., private or public schools), mouth breathing (P = 0.02), as well as the overall prevalence of oral habits (P = 0.03), were

Table 1
Characteristics of the study participants (n. of children = 709).

Variables			N (%)
Parent Information	Relation	Mother	537 (75.74%)
		Father	172 (24.26%)
	Age	20–35	377 (53.17%)
		36–45	285 (40.20%)
		≥ 45	47 (6.63%)
	Mother's age at childbirth	≤ 25	208 (29.34%)
		26–34	388 (54.73%)
		≥ 35	113 (15.93%)
	Monthly family income	≤ 5000 SR	61 (8.6%)
		> 5000–10000 SR	160 (22.57%)
		> 10000–15000 SR	189 (26.66%)
		> 15000 SR	299 (42.17%)
	Mother's level of education	Illiterate /Primary and middle school	27 (3.81%)
		High school	86 (12.13%)
		Bachelor	448 (63.19%)
		Postgraduate studies	148 (20.87%)
Child Information	Age/years	3–4	80 (11.28%)
		> 4–5	629 (88.72%)
	Sex	Male	350 (49.37%)
		Female	359 (50.63%)
	Type of schools	Public	269 (37.94%)
		Private	440 (62.06%)
	Prenatal/natal history	Full-term	674 (95.06%)
		Premature birth	35 (4.94%)

* SR Saudi Riyal.

significantly higher in public schools compared to private schools.

Table 2 demonstrates that the prevalence of malocclusion was 59.10% (95% CI = 55,63) among the study participants. Among the potential relationship variables, none showed a statistically significant difference between those with and without malocclusion, sex (P = 0.86), type of school (P = 0.21), family income (P = 0.62), or parental educational level (P = 0.90).

Table 3 shows an association only between mothers aged 25 years and younger at childbirth with their child malocclusion in primary dentition [OR (95% CI):1.70 (1.04, 2.78)].

4. Discussion

Early detection of malocclusion and its influencing factors is vital for better understanding orthodontic patients, diagnosis, and treatment planning. Previous studies mainly described malocclusion characteristics, not prevalence, and lacked a consensus on the case definition. This study measured malocclusion prevalence using a proposed definition, which considered deviations from normal occlusion as described by (Bishara et al., 1995), and abnormal canine relationships as reported by (Peres et al., 2015).

The malocclusion prevalence in this study was 59.1%. Comparison with other Saudi Arabian studies was limited as they focused on occlusal traits (Almotairy & Almutairi, 2022; Baidas, 2010; Farsi & Salama, 1996). In comparison to global studies, the prevalence was slightly higher than mainland China (45.5%) (Shen et al., 2018) and lower than Shanghai (83.9%) (Zhou et al., 2016), possibly due to genetic, environmental, and behavioral factors. No significant differences were found between both sexes, consistent with (Davidopoulou et al., 2022; Shen et al., 2018) but contradicting (Fernandes et al., 2017; Yadav et al., 2014). The changing Saudi population lifestyle, especially in diet and dietary habits, shifting towards a more Western diet from their traditional one, may contribute to the increased malocclusion prevalence observed in this study.

Our findings revealed that the most frequent terminal planes were mesial-step (55.01%) and flush plane (42.03%), both considered normal. These results align with other national and international studies (Baidas, 2010; Corrêa-Faria et al., 2014).

The reported percentages of class I and class III canine relationships were comparable to national studies (Baidas, 2010; Farsi and Salama, 1996). However, (Baidas, 2010) reported a lower percentage in class II (2.5%) compared to 9.59% in this study, possibly due to the assessment

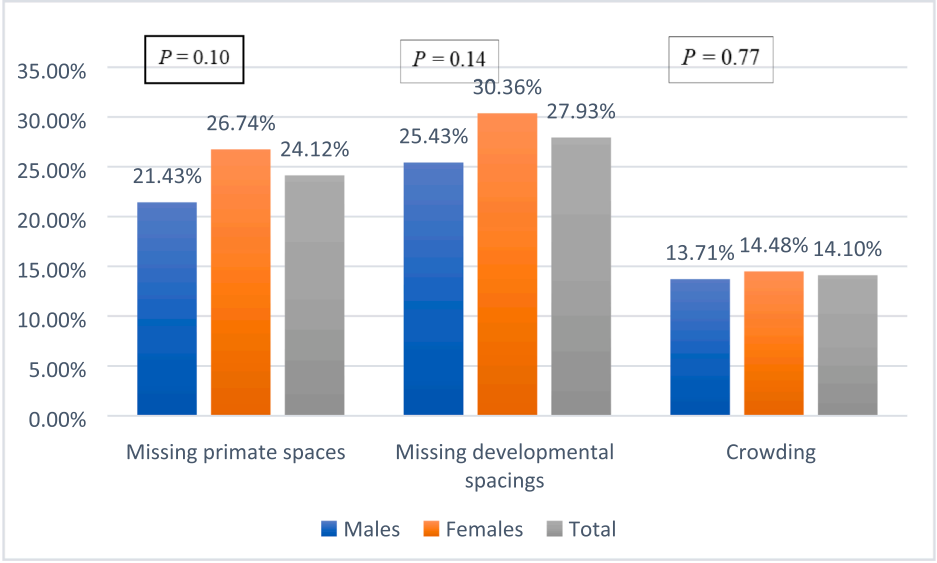

Fig. 1. Frequency distribution of spacing problems in primary dentitions among participants by sex.

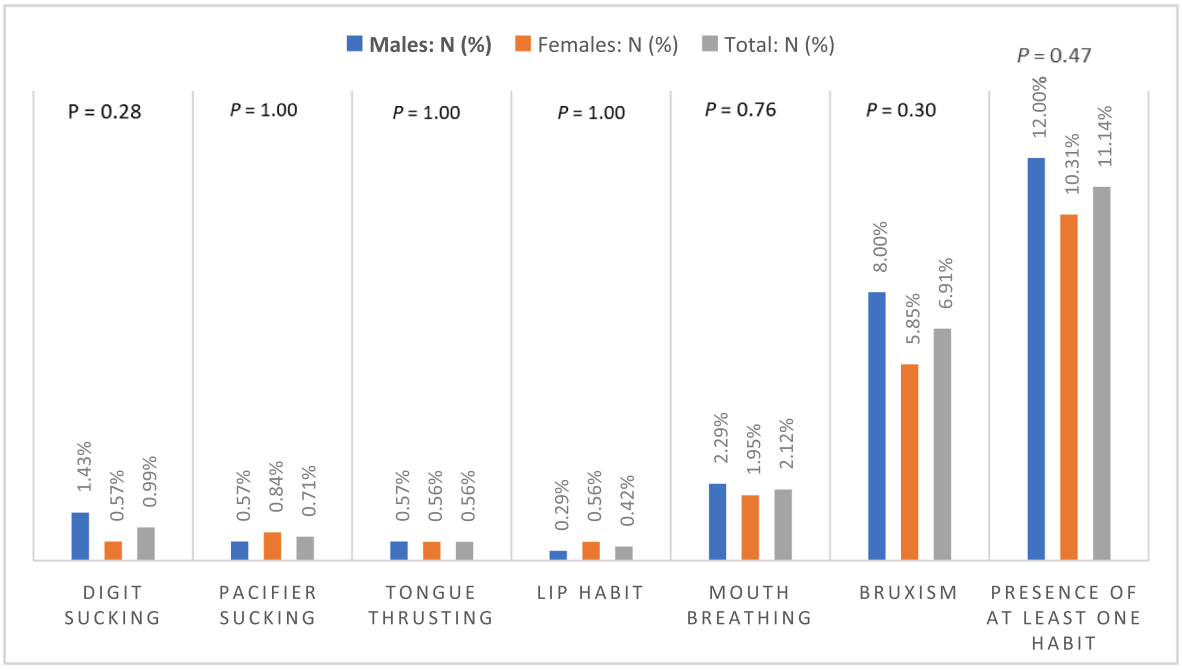

Fig. 2. Frequency distribution of persistent oral habits among participants by sex.

Table 2
Prevalence of malocclusion among participants by sex, school type, and socio-economic status.

Variables		Malocclusion	No malocclusion	P-value
		N (%)		
Child sex	**Males**	208 (49.64%)	142 (48.97%)	0.86
	Females	211 (50.36%)	148 (51.03%)	
School type	**Private school**	252 (60.14%)	188 (64.83%)	0.21
	Public school	167 (39.86%)	102 (35.17%)	
Family income	**≤ 5000 SR**	37 (8.83%)	24 (8.27%)	0.62
	> 5000–10000 SR	88 (21.00%)	72 (24.83%)	
	> 10000–15000 SR	117 (27.92%)	72 (24.83%)	
	> 15000 SR	177 (42.25%)	122 (42.07%)	
Parental educational level	**Illiterate**	2 (0.48%)	3 (1.04%)	^{MC}P = 0.90
	Primary and middle school	13 (3.10%)	9 (3.10%)	
	High school	49 (11.69%)	37 (12.76%)	
	Bachelor	269 (64.20%)	179 (61.72%)	
	Postgraduate studies	86 (20.53%)	62 (21.38%)	
Total		**419 (59.10%)**	**290 (40.90%)**	–

The Chi square test was used.
^{FE}P = Fisher exact test was used.

Table 3
Binary logistic regression for the association of different factors with malocclusion.

Variables		Unadjusted model		Adjusted model	
		OR (95% CI)	P-value	OR (95% CI)	P-value
Mother age at childbirth	**≤ 25**	1.56 (0.98, 2.48)	0.06	1.70 (1.04, 2.78)	0.03*
	26–34	1.32 (0.87, 2.01)	0.20	1.38 (0.89, 2.14)	0.15
	≥ 35	Reference			
Prenatal history	**Full-term**	1.23 (0.62, 2.43)	0.55	1.24 (0.61, 2.50)	0.56
	Premature birth	Reference			
Feeding method	**Breastfeeding**	0.85 (0.55, 1.32)	0.47	0.84 (0.53, 1.32)	0.44
	Bottle feeding	1.27 (0.90, 1.81)	0.18	1.26 (0.88, 1.80)	0.21
	Mixed	Reference			
Family history of malocclusion	**Yes**	1.39 (0.84, 1.2.30)	0.21	1.34 (0.79, 2.25)	0.28
	No	1.18 (0.70, 1.99)	0.53	1.14 (0.67, 1.93)	0.64
	Not aware	Reference			
Persistence of any oral habits	**Yes**	1.38 (0.85, 2.26)	0.20	0.74 (0.44, 1.22)	0.23
	No	Reference			

The model was adjusted for child age, socio-economic status (family income and parental education), and school type.
Model Chi square = 17.56, p value = 0.35, OR = Odds ratio, CI = Confidence interval.

of occlusal characteristics separately for each age level, unlike the total assessment in our study.

The process of shifting from primary to permanent teeth is dynamic. Some occlusal characteristics, such as distal step, class III canine relationship, and crowding, can predict the development of malocclusion in permanent dentition. However, features like deep overbite might be temporary and self-corrected during the process (Davidopoulou et al., 2022). In this study, 26% of participants had deep overbite, and 25.11% exhibited increased overjet, while more than 68% had normal overjet and overbite. The normal overjet observed in this Saudi population was lower than those reported by (Farsi and Salama, 1996) and (Baidas, 2010). This disparity may suggest a potential increase in malocclusion, possibly reflecting changes in lifestyle, diet, and maladaptive oral

behaviors (Anand et al., 2022).

Arch spaces are crucial for the proper alignment of future permanent dentition. Crowding in primary dentition indicates potential malalignment of permanent teeth. Spacing problems in this study couldn't be compared nationally due to unavailable data but were comparable to findings in Arabic and Asian countries (Paulista and Filho, 2014; Sun et al., 2018). The literature suggests self-correction of anterior crossbite, while posterior crossbite persists into permanent dentition, contributing to lateral mandibular shift, temporomandibular joint disorders, and muscle dysfunction (Lochib et al., 2015). Unilateral crossbite was more frequent than bilateral among participants.

Regarding infantile feeding habits, 53% practiced mixed feeding, consistent with Zhou et al.'s findings, which reported the lowest malocclusion prevalence in breastfed children (Zhou et al., 2016). Parents' lack of awareness about their child's malocclusion highlights the importance of early dental care and implementing the dental home concept.

Research shows a clear link between oral habits like pacifier use and digit-sucking and the increased likelihood of developing dental issues like posterior crossbite, Class II canine relationship, increased overjet, and anterior open bite (Zhou et al., 2016). These problems might not be evident if habits cease before permanent incisors eruption, possibly explaining the lack of association between habits in primary dentition and malocclusion in this study. Bruxism was the most prevalent habit, followed by mouth breathing, with no notable gender differences (Kieser and Groeneveld, 1998). Juvenile bruxism is common but typically self-limited, resolving without persistence into adulthood. Bad oral habits were significantly more frequent in public schools, possibly reflecting socio-economic status effects (Hanna et al., 2015).

Among the studied risk factors, only the younger mother's age at childbirth showed a significant association with her child's malocclusion in primary dentition. This connection could be linked to factors like early childhood admission to nurseries, bottle feeding, and soft diets, potentially worsening oral hygiene and increasing caries risk in this young population. These findings differ from other studies that found no such association (Amaral et al., 2017; Bonfadini et al., 2020).

Utilizing case definitions is vital in epidemiology to standardize criteria for identifying cases. A strength of this study is the development of a case definition for malocclusion in primary dentition, facilitating the identification of such cases. This offers a valuable tool for assessing oral health needs, enabling early intervention and community-level monitoring. Nevertheless, the suitability of this proposed case definition requires further validation.

This study has some limitations, including the cross-sectional study design, which assesses the relationship between exposure and outcome without establishing a causality association, limiting the ability to draw definitive conclusions. Furthermore, it is important to acknowledge that the study sample was restricted to the Riyadh region of Saudi Arabia, and therefore, the findings may not be fully generalizable to all regions in the country.

In conclusion, based on the proposed case definition, the prevalence of primary dentition malocclusion among a group of Saudi preschool children was considerably high. Increased overbite and overjet were the most prevalent occlusal discrepancies, followed by arch spacing problems. The younger mother's age at childbirth is significantly associated with her child's malocclusion. The study results can serve as a baseline for future investigations.

Ethical statement

Ethical clearance was obtained from the Institutional Review Board of Princess Nourah bint Abdulrahman University (Reference number:**180240**).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2023.09.003.

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