Risk Factors in the Formation of Maxillofacial Anomalies in Children and Adolescents

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Abstract

Background: Maxillofacial anomalies are among the most widespread structural pathologies in pediatric dentistry, affecting both aesthetics and function of the orofacial complex. Despite advancements in diagnostic technology and orthodontic treatment, the prevalence of these anomalies remains high worldwide. Epidemiological data indicate that up to 95% of adolescents may be affected, depending on age, sex, and regional factors. These anomalies are often multifactorial in origin, involving genetic, epigenetic, and socio-environmental determinants that interact during the stages of craniofacial development. While many risk factors have been proposed, there remains a lack of consensus regarding their relative influence, especially within localized contexts .

Aim: The objective of this study was to identify and stratify socio-biological risk factors associated with the development of maxillofacial anomalies in children and adolescents aged 6 to 16. The study aimed to distinguish between modifiable (controllable) and non-modifiable (uncontrollable) risk factors, with a focus on regional and familial characteristics .

Methods: A cross-sectional case-control study was conducted in Kutaisi, Georgia, involving 239 pediatric patients. Of these, 154 children diagnosed with maxillofacial anomalies constituted the case group, while 85 children without orthodontic pathology served as the control group. Clinical assessments, panoramic radiography, and ICD-10 classification codes were used to confirm diagnoses. Data on prenatal, perinatal, and postnatal conditions, as well as socio-economic indicators and family history, were collected via structured questionnaires. Statistical analyses were performed using SPSS v21, with Pearson's chi-squared test and logistic regression applied to determine associations. Odds Ratios (OR) and 95% Confidence Intervals (CI) were calculated, with statistical significance set at $p < 0.05$.

Results:The most common diagnosis was tooth position anomaly (98.7%), followed by arch proportion disorders (67.5%) and temporomandibular dysfunction (18.2%). Statistically significant risk factors included mouth breathing or open-mouth posture (OR = 3.99, $p < 0.001$), frequent respiratory infections (OR = 4.78, $p < 0.001$), difficulty breathing (OR = 4.32, $p = 0.013$), prematurity (OR = 3.85, $p = 0.024$), and medication allergies (OR = 3.20, $p = 0.031$). Paternal history of maxillofacial anomalies was also significantly associated (OR = 1.99, $p = 0.038$). Socioeconomic factors such as unsatisfactory living conditions and single-parent families showed elevated ORs but did not achieve statistical significance .

Conclusions: This study highlights the complex and multifactorial etiology of maxillofacial anomalies in children. A combination of hereditary predisposition, prenatal complications, and postnatal respiratory and behavioral factors significantly increases the risk. Early identification and mitigation of controllable risk factors are critical for effective prevention and public health planning in pediatric populations . **(TCM-GMJ May 2026; 11 (1): P22-P26)**

Keywords: Maxillofacial anomalies; Pediatric risk factors; Hereditary influence; Orthodontic epidemiology.

Introduction

Despite the introduction of high-tech diagnostic and treatment methods, the prevalence of maxillofacial anomalies in the population of children and adolescents remains high (Djuraeva Sh., 2022; Drenski Balija N., 2022). Maxillofacial anomalies are among the most frequently observed (80–90%) pathologies. Their prevalence in children aged 3 to 7 is 59.3%, while among adolescents it ranges from 41.1% to 95.3% (Olesov E., 2019). The most common forms of pathology include: congenital absence of teeth (34.4%), impacted teeth (9.4%), enamel hypoplasia (7.2%), and others (1.6–6.3%) (Temilola DO, 2014; Scheffel DLS, 2014; Folayan MO, 2019).

The level of dental morbidity during childhood and adolescence significantly determines an individual's health status in later life. For this reason, epidemiological data on maxillofacial pathology continues to be a key area of interest for professionals (Roberts MW, 2008; Eaton KA,

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Social and biological factors play a significant role in the development of dental anomalies, including prenatal history, dietary habits, the child's growth and developmental conditions, family background, hereditary diseases of the maxillofacial system, and other local or systemic factors that act both before and after birth (Christensen LB, 2010; Chaffee BW, 2017; Naidu RS, 2021). Of particular importance is the combined influence of genetic, epigenetic, and socio-economic factors during the stages of morpho-differentiation or histo-differentiation in dental development (Chuykin S., 2019; Danilova MA, 2023).

Special attention is given to deforming harmful habits, which can lead to malocclusion and have negative effects on a child's speech, physical, and emotional development (Dolatabadi S., 2022).

The multifactorial origin of maxillofacial anomalies determines the wide range of pathogenic mechanisms and risk factors involved in their formation. Although the causes of these anomalies in children and adolescents are being actively studied, there is still no clear answer regarding their specific risk factors and regional characteristics, as epidemiological features vary across different geographic areas (Ushnitsky I., 2019).

The aim of the study was to identify the socio-biological risk factors for the formation of maxillofacial anomalies in early childhood and to stratify controllable and uncontrollable risk factors

Methods

A cross-sectional study was conducted at the Pediatric Dental Polyclinic "Family Dent" in Kutaisi. Based on outpatient visits, the orthodontic status of children aged 6 to 16 was assessed. All participants were residents of an urban environment (Kutaisi city). A total of 239 children were examined.

Inclusion criteria for the study were:

1. Children aged between 6 and 16 years (inclusive)
2. Clinical or radiographic signs of maxillofacial anomalies
3. Satisfactory general somatic health at the time of examination
4. Parental consent for the child's participation in the study

Exclusion criteria were:

1. Partial or complete anodontia due to caries or trauma
2. Physical and/or intellectual developmental disabilities
3. History of orthodontic treatment
4. Congenital anomalies of the maxillofacial system

The diagnosis of maxillofacial pathology was based on anamnesis, dental status, and panoramic radiography, following ICD-10 codes. The study used WHO recommendations for maxillofacial examination.

To identify risk factors, a case-control study was conducted. The case group (main group) consisted of 154 patients with maxillofacial anomalies. The control group included 85 conditionally healthy children of the same age, without any diagnosed dental pathology.

A standardized questionnaire was used, consisting of two parts:

1. The first part included data on the family's socio-economic status, parents' education levels, harmful habits, general health status, and the presence of dental pathologies in parents and close relatives. It also collected information on early childhood nutrition, anthropometric data, and somatic health during ontogenesis.
2. The second part covered orthodontic indicators.

Statistical analysis was performed using the SPSS/v21 software package. To assess differences between groups and conduct multivariate regression analysis, Pearson's chi-squared test (χ^2) was used with a significance level of $p<0.05$. For potential risk factors, Odds Ratios (OR) and 95% Confidence Intervals (CI) were calculated.

Results and discussion

A total of 239 patients aged 6 to 16 were studied. Among children with maxillofacial pathology, 98.7% (154 patients) exhibited tooth position anomalies (Code K07.3). Additionally, 67.5% were diagnosed with anomalies in the proportion of the dental arch (Code K07.2), 24.03% had functional anomalies in the maxillofacial area (Code K07.5), and 18.18% had temporomandibular joint pathology (Code K07.6). In many cases, multiple anomalies were present concurrently, while anodontia was rare.

The majority of examined participants were ethnically Georgian (98.1%). The average age in the main (case) group was 13.5 ± 2.0 years, while in the control group it was 10.7 ± 2.8 years (see Table 1).

The majority of authors believe that the prevalence of pathology differs across various age and gender groups. Dental anomalies are more commonly found in boys than in girls. Furthermore, each region has its own individual frequency characteristics of anomalies (King NM, 2008; McKinney R, 2023).

It is well known that both general somatic and orthodontic health in children is affected by socio-economic factors, including: parental education, family income level, social status, and more. Researchers assume that socio-economic disparities and inequalities have an influence on lifestyle and health outcomes (Hanson M, 2007; Christensen L, 2010).

The analysis of family and socio-economic characteristics revealed a high frequency of parents with a medium level of education in both groups. The number of single-parent families was somewhat higher in the main group (14.9%) compared to the control group (10.6%) (see Table 2).

Analysis

According to the Odds Ratios (OR), the most notable associations were found for:

- Unsatisfactory living conditions (OR = 2.520)
- Conflict/stressful family environment (OR = 2.079) Both had a chi-squared value (χ^2) greater than 2, indicating a tendency toward statistical significance. Weaker associations were observed with:
- Single-parent families (OR = 1.483)
- Mother's secondary education (OR = 1.181)
- Father's secondary education (OR = 1.140)

In terms of hereditary risk, there was a notably high prevalence of maxillofacial pathology in parents.

- The OR in mothers was 1.779 (suggestive but not statistically significant).
- In fathers, the OR was 1.988, and this result was statistically significant (CI: 1.032–3.830, $\chi^2 = 4.315$, $p = 0.038$).

For siblings and close relatives, the OR was also greater than 1, but due to the small number of cases, the reliability of these results is considered low.

Other Prenatal Risk Factors

Additional risk factors for maxillofacial anomalies include maternal and fetal health conditions during pregnancy, such as:

- Toxicosis
- Anemia
- Threat of miscarriage
- Premature birth
- Birth trauma
- Asphyxia, etc.

In this study, pregnancy complications (e.g., gestosis, anemia, thyroid disorders, medication exposure) were similarly distributed across both groups and did not show significant differences.

However, threat of spontaneous abortion (OR = 2.733) and prematurity (OR = 3.847, $p = 0.024$) showed a stronger association with maxillofacial pathology.

Newborn Anthropometric Data measurements were consistent with gestational age.

- Case group average weight: 3281.6 ± 671.9g (median: 3300), average length: 50.7 ± 6.4cm (median: 51)
- Control group average weight: 3338.2 ± 547.2g (median: 3300), average length: 51.2 ± 2.0cm (median: 51).

Feeding patterns in the case group:

- Breastfeeding: 39.6%
- Formula feeding: 31.2%
- Mixed feeding: 29.2%

The control group showed a similar distribution.

Postnatal Risk Factors

The study focused on conditions affecting a child's immune biological reactivity and deforming harmful habits. These are detailed in Table 3, which follows.

Frequent respiratory infections (OR = 4.777, $p = 0.000$), medication allergies (OR = 3.197, $p = 0.031$), mouth breathing/open-mouth posture (OR = 3.992, $p = 0.000$), and difficulty breathing (OR = 4.316, $p = 0.013$) were statistically significant risk factors with high levels of association. Food allergy showed a moderate association (OR = 1.568). Among harmful habits, prolonged pacifier use (OR = 1.476) appeared notable as it may contribute to the development of maxillofacial anomalies.

Co-occurring somatic conditions in children with maxillofacial pathology included:

- Postural disorders (32.5%)
- Osteoarticular dysplasia (13.6%)
- Adenoiditis (13.6%)
- Chronic tonsillitis (14.3%)
- Chronic bronchitis (7.8%)

The multifactorial origin of maxillofacial anomalies results in a wide variety of contributing factors. This study applied a case-control method to analyze predisposing and supporting factors for anomaly development. Both modifiable (e.g., living conditions) and less modifiable (e.g., hereditary and biological) factors were identified.

Among socio-demographic indicators, unsatisfactory housing, conflictual or single-parent households, and low parental education emerged as important factors. However, expert opinion varies, and associations between dental health and socio-economic factors remain inconclusive due to differing study scales, methodologies, and focus on specific variables (e.g., income, maternal education, residence type) (Hanson M.D., 2007; Christensen LB, 2010; Paula J.S., 2012; Minervini G, 2023).

In terms of hereditary predisposition, maxillofacial anomalies were more frequently found in parents than in siblings or other relatives—particularly significant in fathers ($p = 0.038$). In general, inherited anomalies make up about 14.0% of dental diseases (Ushnitsky I.D., 2019).

The study confirmed a strong association between spontaneous abortion risk, prematurity ($p = 0.024$), and anomaly development—supporting theories of teratogenic exposure during pregnancy, which reduces maternal resistance and increases fetal vulnerability (Vliyaniye, 2011).

In early childhood, frequent respiratory infections ($p = 0.000$) and medication allergies ($p = 0.031$) were of particular concern. Deforming habits (mouth breathing, breathing difficulties, pacifier use) were explained by parental inexperience and improper feeding practices—especially among girls (Romagosa DE). Deforming habits are observed in 56%–75% of children and are defined as non-functional repetitive behaviors that disrupt neuromuscular balance and contribute to skeletal-dental disharmony (Romagosa DE).

Maxillofacial anomalies and their associated structural and functional disorders negatively impact children's somatic health. This is confirmed by causal links between dental and systemic pathologies (e.g., endocrine, allergic diseases, and orthodontic disorders) (Reissmann D.R., 2013; Dolatabadi S, 2022). Among the studied group, postural issues, osteoarticular dysplasia, and chronic inflammatory foci (e.g., adenoiditis, tonsillitis) were predominant.

Conclusion

The study successfully identified regional risk factors that are crucial for primary prevention. Awareness of risk markers is essential for identifying high- and low-risk groups and guiding secondary prevention strategies. By eliminating modifiable risk factors, the formation of maxillofacial anomalies in early childhood may be significantly reduced.

Each link in the complex chain of causation may act as either a trigger or contributing condition. Thus, the main approach to preventing maxillofacial anomalies lies in identifying and mitigating risk factors.

Table 1. Distribution by Age and Gender (n = 239)

Group (n=239)	Gender	Age			Total
		6–9	10-12	13-16	
With orthodontic pathology (n = 154)	Girls	5 (3.25%)	9 (5.84%)	94 (61.04%)	108 (70.13%)
	Boys	2 (1,3%)	9 (5.84%)	35 (22.73%)	46 (29.87%)
Without orthodontic pathology (n = 85)	Girls	16 (18.82%)	10 (11.76%)	11 (12.94%)	37 (43.53%)
	Boys	19 (22.35%)	11 (12.94%)	18 (21.18%)	48 (56.47%)

Table 2. Basic Characteristics of the Comparison Groups

Characteristics	Case (n=154)	Control (n=85)	OR	CI	χ^2	p
Unsatisfactory living conditions	13(8,4%)	3(2,5%)	2.520	0.697-9.105	2.116	0.146
Average-income family	109(70,8)	60(70,6%)	1.009	0.564-1.806	0.001	0.975
Single-parent family	23(14,9%)	9(10,6%)	1.483	0.652-3.369	0.892	0.345
Conflict/stressful family environment	21(13,6)	6(7,06%)	2.079	0.805-5.370	2.365	0.124
Mother with secondary education	43(27,9%)	21(24,7%)	1.181	0,644-2.164	0,289	9.591
Father with secondary education	40(25,9%)	20(23,5%)	1.140	0,615-2,114	0.174	0.677
Both parents with secondary education	23(14,9%)	18 (21,2%)	0.654	0.330-1.294	1.501	0.220
Maxillofacial anomalies in mothers	40 (25,9%)	14 (16,5%)	1.779	0.904-3.502	2.828	0.093
Maxillofacial anomalies in fathers	46(29,8%)	15 (17,6%)	1.988	1.032-3.830	4.315	0.038
Maxillofacial anomalies in siblings	9 (5,8%)	1(1,2%)	5.214	0.649-41.87	2.976	0.084
Maxillofacial anomalies in close relatives	13(8,4%)	2 (2,6%)	3.826	0.843-17.37	3.452	0.063

Table 3. Postnatal Risk Factors

Risk Factors	Case (n=154)	Control (n=85)	OR	CI	χ^2	P
Frequent respiratory	41(26,6%)	6 (7,1%)	4.777	1.935-11.79	13.27	0.000
Food allergies	19(12,3%)	7(8,2%)	1.568	0.631-3.897	0.951	0.330
Medication allergies	21(13,6%)	4(4,7%)	3.197	1.060-9.647	4.664	0.031
Low birth weight	7(4,5%)	1(1,2%)	4.000	0.484-33.071	1.921	0.166
Overweight	6(3,9%)	1(1,2%)	3.405	0.403-28.76	1.425	0.233
Mouth breathing / open-mouth posture	71(46,1%)	15(17,6%)	3.992	2.102-7.581	19.254	0.000
Difficulty breathing	21(13,6%)	3(3,5%)	4.316	1.248-14.92	6.193	0.013
Prolonged pacifier use	37(24,03%)	15(17,6%)	1.476	0.756-2.881	1.309	0.253
Thumb or fist sucking	9 (5,8%)	6(7,1%)	0.817	0.281-2.380	0.137	0.711

Table 4. Key Risk Factors for the Development of Maxillofacial Anomalies

N	Risk Factors	OR	P
1	Unsatisfactory living conditions	2.520	0.146
2	Single-parent family	1.483	0.345
3	Conflicting family environment	2.079	0.124
4	Anomalies in mothers	1.779	0.093
5	Anomalies in fathers	1.988	0.038
6	Threat of spontaneous abortion	2.733	0.109
7	Prematurity	3.847	0.024
8	Frequent respiratory infections	4.777	0.000
9	Food allergy	1.568	0.330
10	Medication allergy	3.197	0.031
11	Mouth breathing/open-mouth posture	3.992	0.000
12	Difficulty breathing	4.316	0.013
13	Prolonged pacifier use	1.476	0.253

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