DOI: https://doi.org/10.17816/dent627220

The influence of oral breathing type on the formation of occlusion in students of general educational institutions of the Ministry of Defense of Russian Federation

Natalia A. Sokolovich[1], Anastasiya A. Saunina[1], Vladimir V. Dvoryanchikov[2], Anatoli A. Lunev[1], Ivan K. Soldatov[3], Olga S. Donskaya[4, 5]

[1] St Petersburg University, Saint Petersburg, Russia;
[2] Saint-Petersburg Research Institute of Ear, Throat, Nose and Speech, Saint Petersburg, Russia;
[3] Military Medical Academy named after S.M. Kirov, Saint Petersburg, Russia;
[4] Academician I.P. Pavlov First St. Petersburg State Medical University, Saint Petersburg, Russia;
[5] Saint Petersburg Medical and Social Institute, Saint Petersburg, Russia

ABSTRACT

BACKGROUND: Among students of general education organizations of the Ministry of Defense of Russian Federation, respiratory diseases is the leading cause of general somatic morbidity and amount to 1543.5‰. When examining students, pathology of the upper respiratory tract is often diagnosed, such as partial or complete obstruction of the nasopharynx and/or oropharynx. Against this background, the formation of the oral type of breathing occurs, which affects the state of general somatic health and growth and development of the facial skeleton.

AIM: To evaluate the influence of oral breathing on the dentoalveolar and gnathic parameters of the maxillofacial region in students of educational institutions of the Ministry of Defense of Russian Federation.

MATERIALS AND METHODS: This study examined two groups of students aged 13–15 years from the St. Petersburg Cadet Military Corps named after Prince Alexander Nevsky: group 1, 30 cadets with oral breathing, and group 2 (control), 30 cadets with nasal breathing. All patients underwent an examination of the oral cavity, a photo protocol, scanning of the dentition, and cone-beam computed tomography of the skull bones and first cervical vertebrae in natural occlusion with a resolution of 17×15. The data were checked for normal distribution of features. The article presents arithmetic averages and their errors (M±m).

RESULTS: All the examined group 1 students with oral breathing were diagnosed with distal bite in combination with other dental anomalies: combined anomalies in the form of distal bite and disocclusion in the frontal region (56.7%); close position of the anterior group of teeth (93.3%); and unilateral (30.0%) and bilateral (13.3%) cross occlusion due to narrowing of the upper and lower jaws. In most cases, the group 1 students were diagnosed with a gnathic form of dentoalveolar anomaly (ANB parameter, 6.6±2.4°; Beta parameter, 24.7±3.1°) against the background of retroposition of the lower jaw (SNB parameter, 75.4±2.8°) and a decrease in the length of the lower jaw (Co–Gn parameter, 106.0±2.8 mm). All the group 2 (control) students had a neutral occlusion with a normal position of the upper jaw (SNA parameter, 81.4±2.1°) and a normal position of the lower jaw (SNB parameter, 79.8±1.6°) and the first skeletal class (ANB parameter, 2.3±1.1°; Beta parameter, 30.1±2.5°).

CONCLUSION: Oral breathing is accompanied by the development of disto-occlusion with the formation of a vertical gap in combination with cross occlusion in the lateral sections and close position of the anterior group of teeth against the background of a narrowing of the upper and lower jaws. Prompt diagnosis of upper respiratory tract pathology prevents the development of dentoalveolar and gnathic disorders of the maxillofacial area. To treat patients with oral breathing, a simultaneous approach is required with the involvement of a full-time otolaryngologist at the medical center.

Keywords: children's dentistry; cadets; cadet corps; oral breathing type; orthodontics; dentofacial anomalies; distoocclusion.

To cite this article:
Sokolovich NA, Saunina AA, Dvoryanchikov VV, Lunev AA, Soldatov IK, Donskaya OS. The influence of oral breathing type on the formation of occlusion in students of general educational institutions of the Ministry of Defense of Russian Federation. *Russian Journal of Dentistry*. 2024;28(1):29–38. DOI: https://doi.org/10.17816/dent627220

Received: 19.12.2023 **Accepted:** 29.12.2023 **Published online:** 15.03.2024

DOI: https://doi.org/10.17816/dent627220

Влияние ротового типа дыхания на формирование прикуса у воспитанников общеобразовательных организаций Министерства обороны Российской Федерации

Н.А. Соколович[1], А.А. Саунина[1], В.В. Дворянчиков[2], А.А. Лунев[1], И.К. Солдатов[3], О.С. Донская[4, 5]

[1] Санкт-Петербургский государственный университет, Санкт-Петербург, Россия;
[2] Санкт-Петербургский научно-исследовательский институт уха, горла, носа и речи, Санкт-Петербург, Россия;
[3] Военно-медицинская академия имени С.М. Кирова, Санкт-Петербург, Россия;
[4] Первый Санкт-Петербургский государственный медицинский университет имени академика И.П. Павлова, Санкт-Петербург, Россия;
[5] Санкт-Петербургский медико-социальный институт, Санкт-Петербург, Россия

АННОТАЦИЯ

Актуальность. Среди воспитанников общеобразовательных организаций Министерства обороны Российской Федерации болезни органов дыхания занимают первое место в структуре общесоматической заболеваемости и составляют 1543,5‰. При осмотре обучающихся также часто диагностируют патологию верхних дыхательных путей в виде частичной или полной обструкции носоглотки и/или ротоглотки. На этом фоне происходит формирование ротового типа дыхания, который влияет не только на состояние общесоматического здоровья, но и на рост и развитие лицевого скелета.

Цель исследования — оценить влияние ротового типа дыхания на зубоальвеолярные и гнатические параметры челюстно-лицевой области у воспитанников общеобразовательных организаций Министерства обороны Российской Федерации.

Материалы и методы. Обследовано две группы воспитанников Санкт-Петербургского кадетского военного корпуса имени князя Александра Невского в возрасте 13–15 лет: первая — 30 кадетов с ротовым типом дыхания; вторая (группа контроля) — 30 кадетов с носовым типом дыхания. Всем пациентам проведён осмотр полости рта, выполнены фотопротокол, сканирование зубных рядов, конусно-лучевая компьютерная томография костей черепа и первых шейных позвонков в естественной окклюзии с разрешением 17×15. Данные проверили на нормальность распределения признаков. В статье представлены средние арифметические величины и их ошибки (M±m).

Результаты. Среди обследованных воспитанников первой группы с ротовым типом дыхания у всех 100% диагностирован дистальный прикус в сочетании с другими зубочелюстными аномалиями: сочетанные аномалии в виде дистального прикуса и дизокклюзии во фронтальном отделе — у 56,7%; тесное положение передней группы зубов — у 93,3%; односторонняя — у 30,0% и двусторонняя — у 13,3% перекрёстная окклюзия на фоне сужения верхней и нижней челюсти. У воспитанников первой группы в большинстве случаев также диагностирована гнатическая форма зубочелюстной аномалии (параметр ANB составил 6,6±2,4°, параметр Beta — 24,7±3,1°) на фоне ретроположения нижней челюсти (параметр SNB составил 75,4±2,8°) и уменьшения длины нижней челюсти (параметр Co–Gn составил 106,0±2,8 мм). У воспитанников второй группы (группа контроля) в 100% случаев выявлен нейтральный прикус с нормоположением верхней челюсти (параметр SNA составил 81,4±2,1°), нормоположением нижней челюсти (параметр SNB составил 79,8±1,6°) и первым скелетным классом (параметр ANB составил 2,3±1,1°, параметр Beta — 30,1±2,5°).

Заключение. Ротовой тип дыхания сопровождается развитием дистоокклюзии с формированием щели по вертикали в сочетании с перекрёстной окклюзией в боковых отделах и тесным положением передней группы зубов на фоне сужения верхней и нижней челюсти. Своевременная диагностика патологии верхних дыхательных путей позволит предотвратить развитие зубоальвеолярных и гнатических нарушений челюстно-лицевой области. Для лечения пациентов с ротовым типом дыхания необходим симультанный подход с привлечением штатного врача-оториноларинголога медицинского пункта.

Ключевые слова: детская стоматология; воспитанники; кадетский корпус; ротовой тип дыхания; ортодонтия; зубочелюстные аномалии; дистоокклюзия.

Как цитировать:
Соколович Н.А., Саунина А.А., Дворянчиков В.В., Лунев А.А., Солдатов И.К., Донская О.С. Влияние ротового типа дыхания на формирование прикуса у воспитанников общеобразовательных организаций Министерства обороны России // Российский стоматологический журнал. 2024. Т. 28, № 1. С. 29–38. DOI: https://doi.org/10.17816/dent627220

Рукопись получена: 19.12.2023 **Рукопись одобрена:** 29.12.2023 **Опубликована online:** 15.03.2024

BACKGROUND

The growth and development of the craniofacial region result from the interaction of genetic and epigenetic factors. According to the functional matrix theory (Moss, 1969), the growth of skeletal structures occurs under the control of and in accordance with the activity of the masticatory and facial muscles [1]. Therefore, proper development of the dentofacial complex requires the fulfillment of several biomechanical conditions: patency of the upper airway and adequate activity of the dentofacial system musculature [2].

Mew (2018) demonstrated that harmonious development of the dentofacial system is possible when myodynamic balance among intraoral structures is maintained for at least 4 to 8 hours daily [3]. Mouth breathing disrupts this myodynamic balance.

Currently, mouth breathing is defined as respiration through the oral cavity not only during intense physical exertion but also at rest (Souki et al., 2009) [4]. Normally, all inhaled and exhaled airflow passes through the nasal cavity.

In medical units and health facilities of the Ministry of Defense of the Russian Federation, mouth breathing associated with partial or complete upper airway obstruction is frequently observed. Etiologic factors contributing to mouth breathing include otolaryngologic disorders such as pharyngeal lymphoid tissue hyperplasia, deviated nasal septum, nasal polyps, postoperative scarring, allergic rhinitis, turbinate hypertrophy associated with allergies, and chronic infectious processes of the nasal mucosa [5].

Mouth breathing has systemic consequences: it promotes chronic hypoxia and hypercapnia, resulting in a shift of the acid-base balance toward respiratory acidosis. For example, Petrova et al. (2022) demonstrated that patients with mouth breathing have a 20% higher blood carbon dioxide concentration [5]. Inadequate oxygenation caused by mouth breathing lead to cognitive impairment, problems with perception and sensorimotor integration, decreased attention, and memory deficits, which in turn result in poor school performance [6]. Notably, restoration of nasal breathing improves learning ability [7].

The anatomical and functional interrelation between the respiratory system and dentofacial structures [8] substantially affects the prevention and treatment of otorhinolaryngologic diseases and malocclusion [9–11], as well as overall population health [12–14].

In 1872, Tomes introduced the term adenoid facies to describe characteristic dentofacial changes associated with mouth breathing: lip incompetence, maxillary constriction, mandibular incisor retrusion, maxillary incisor protrusion, anterior open bite, increased lower facial height, increased gonial angle, and mandibular retroposition [15].

It is important to note that impaired craniofacial development influences how a child's appearance is perceived by peers, which in turn affects psychological well-being. According to our previous study [16], patients with malocclusion exhibited higher levels of anxiety.

Timely diagnosis and treatment of morphofunctional disturbances of the dentofacial system in children with upper airway pathology remain a pressing issue in dentistry. Prior studies have shown a high prevalence of dentofacial anomalies among various regulated cohorts within the Ministry of Defense of the Russian Federation. For example, 39.6% of students in general education institutions of the Ministry had dentofacial anomalies [17]; among conscripts, the prevalence was 72.2% [18]; among university applicants, 64.3% [19]; and among military cadets, 44.2% [20]. Class II malocclusion (disto-occlusion) was diagnosed in 20.5%, 22.4%, and 10.1% of examined individuals, respectively [21].

Early identification of etiopathogenetic factors of malocclusion can prevent the development not only of dentoalveolar and skeletal forms of malocclusion but also of multiple systemic diseases during growth and development.

This work aimed to evaluate the impact of mouth breathing on dentoalveolar and skeletal parameters of the craniofacial complex in students of general education institutions of the Ministry of Defense of the Russian Federation.

MATERIALS AND METHODS

During routine medical examinations at the Saint Petersburg Cadet Military Corps named after Prince Alexander Nevsky, two groups of children aged 13–15 years were selected: group 1 included 30 cadets with mouth breathing, and group 2 (control group) included 30 cadets with nasal breathing.

Inclusion criteria:

- age of 13–15 years;
- presence of mouth or nasal breathing pattern;
- complete eruption of all permanent first and second molars;
- availability of cone-beam computed tomography (CBCT) scans of the cranial bones and first cervical vertebrae in habitual occlusion with a field of view of 17 × 15 cm.

All participants underwent intraoral examination, photographic documentation, dental arch scanning, and CBCT of the cranial bones and first cervical vertebrae in habitual occlusion with a field of view of 17 × 15 cm. The mean age of participants was 13.3 ± 1.2 years. The collected data were entered into the authors' proprietary database [22] and recorded in dental patient charts completed in accordance with World Health Organization recommendations (form 043/u).

The clinical examination assessed facial symmetry, depth of nasolabial folds, and lip competence at rest. Special attention was given to the position of the cervical spine, presence of kyphosis or lordosis, and shoulder alignment. Intraoral examination focused on occlusal discrepancies in the sagittal, vertical, and transverse planes.

The photographic protocol included intraoral photographs: frontal view (see Fig. 1, *a*), right and left buccal views (see Fig. 1, *b*, *c*), as well as extraoral facial photographs used to analyze facial proportionality and symmetry, soft-tissue characteristics, and lip seal. Frontal facial photographs were taken in two conditions: with a habitual smile to evaluate incisor display and possible occlusal cant, and without a smile to assess facial symmetry. Profile photographs were taken at a 90° angle to the facial midline.

For assessment of anthropometric parameters, dental arch scans of the maxilla and mandible were obtained using the Medit i-700 scanner (Medit, South Korea). The scans were analyzed to evaluate transverse arch dimensions according to Pont's method (1909). Anterior maxillary width was defined as the distance between the midpoints of the occlusal fissures of the first premolars. Posterior maxillary width was measured as the distance between the deepest points of the primary fissures or the anterior intersections of the fissures of the permanent first molars. Anterior mandibular width was defined as the distance between the distal contact points of the first premolars. Posterior mandibular width was measured as the distance between the distal buccal cusps (in 4-cusp molars) or the middle cusps (in 5-cusp molars) of the permanent first molars (Fig. 2) [23].

The individual normative width of the dental arch in the premolar region was calculated according to the sum of the mesiodistal widths of the maxillary incisors (SI) using the formula: Anterior dental arch width = SI × 1.25. The individual normative width of the dental arch in the molar region was calculated using the formula: Posterior dental arch width = SI × 1.54.

To aid diagnosis prior to orthodontic treatment, all participants underwent CBCT of the cranial bones and first cervical vertebrae in habitual occlusion with a field of view of 17 × 15 cm. This enabled 3-dimensional cephalometric analysis using Dolphin software, with preliminary orientation of the images in three planes (see Fig. 3). Subsequently, cephalometric parameters were assessed (see Table 1). The data were tested for normal distribution. Arithmetic means and standard errors (M ± m) are reported [24].

Fig. 1. Patient N., 14 years old, group 1. Class II malocclusion; maxillary constriction in the premolar and molar regions; maxillary incisor protrusion; supraposition of tooth 23 (ISO/FDI designation); presence of a supernumerary tooth 22; deviation of the esthetic midline in the mandible; and catarrhal gingivitis. ICD-10 diagnosis: Disto-occlusion, K07.20. *a*, frontal view of dental arches; *b*, right buccal view; *c*, left buccal view.

DOI: https://doi.org/10.17816/dent627220

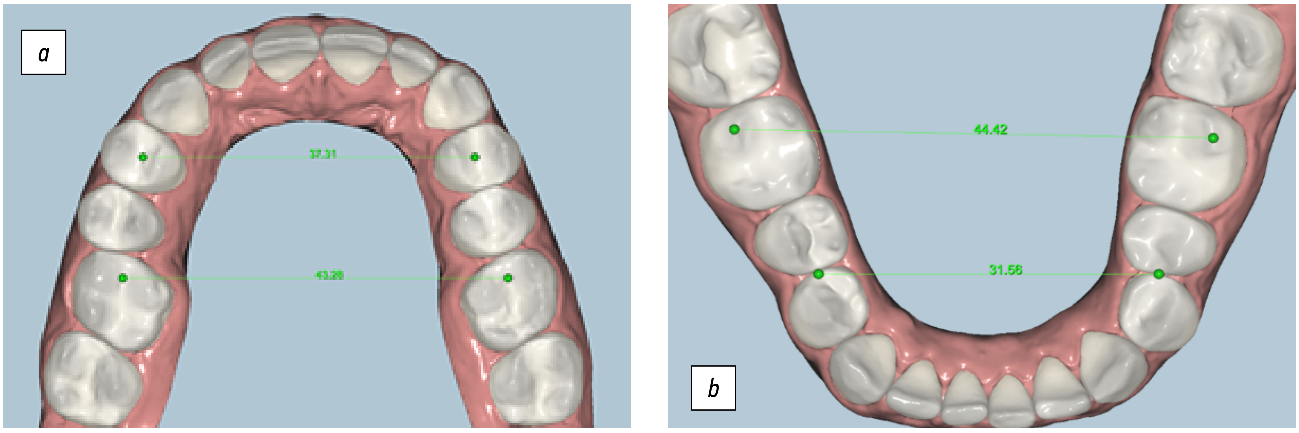

Fig. 2. Measurement of anterior and posterior arch width of the maxilla and mandible according to Pont's method. *a*, anterior maxillary width—line connecting the midpoints of the fissures of the first premolars; posterior maxillary width—line connecting the deepest point of the principal fissure or the anterior intersection of the fissures of the permanent first molars. *b*, anterior mandibular width—line connecting the distal contact points of the first premolars; posterior mandibular width—line connecting the distal buccal cusps (in 4-cusp molars) or middle cusps (in 5-cusp molars) of the permanent first molars.

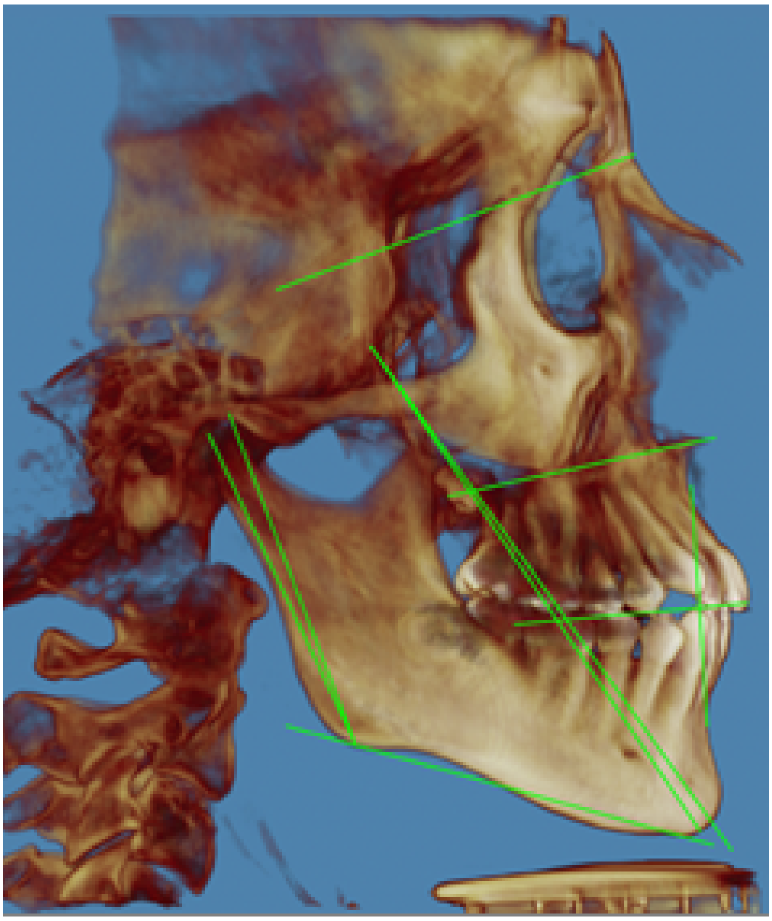

Fig. 3. Patient A., 13 years old, group 1. Results of 3-dimensional cephalometric analysis performed with Dolphin software (Dolphin Imaging & Management Solutions, Chatsworth, CA, USA).

Table 1. Cephalometric parameters assessed

Parameters	Description
∠SNA, °	Position of the maxillary apical base relative to the cranial base line
∠SNB, °	Position of the mandibular apical base relative to the cranial base line
∠ANB, °	Relationship between the maxillary and mandibular apical bases in the sagittal plane
∠Beta, °	Relationship between the maxillary and mandibular apical bases in the sagittal plane
∠U1–L1, °	Interincisal angle, characterizing the labiolingual inclination of the maxillary and mandibular incisors
Co–Gn, mm	Effective mandibular length
ANS–PNS, mm	Maxillary length

RESULTS

Examination of cadets with a mouth breathing pattern revealed the following features: lip seal incompetence at rest, periorbital dark circles associated with hypoxia, flattened nasolabial folds due to increased lower facial height, cervical lordosis, and anterior shoulder posture. Intraoral examination of dental arches in group 1 (mouth breathing) showed that 100% of cadets had Class II malocclusion, which was combined with other dentofacial anomalies: anterior crowding in 93.3%, unilateral crossbite in 30.0%, and bilateral crossbite in 13.3%, all associated with maxillary and mandibular constriction. Combined anomalies were also observed, including Class II malocclusion with anterior open bite in 56.7% of cases. In contrast, in the control group with habitual occlusion, anterior crowding was diagnosed in only 6.7% of cases (see Table 2).

Analysis of transverse arch dimensions based on 3-dimensional dental models demonstrated significant constriction of both the maxilla and mandible in group 1. In cadets with mouth breathing, premolar width was reduced by 5 mm in the maxilla and 3 mm in the mandible, while molar width was reduced by 3 mm in both jaws. Cadets in the control group had normal maxillary and mandibular arch widths (Table 3).

Three-dimensional cephalometric analysis showed that most cadets in group 1 had mandibular retroposition (SNB, 75.4 ± 2.8°) and skeletal class II (ANB, 6.6 ± 2.4°; Beta angle, 24.7 ± 3.1°) accompanied by bimaxillary incisor protrusion (interincisal angle, 126.0 ± 3.4°). In addition, group 1 cadets demonstrated reduced mandibular length (Co–Gn, 106.0 ± 2.3 mm) and increased maxillary length (ANS–PNS, 50.03 ± 2.40 mm). In group 2 (nasal breathing), maxillary position was normal (SNA, 81.4 ± 2.1°), mandibular position was normal (SNB, 79.8 ± 1.6°), skeletal class I was observed (ANB, 2.3 ± 1.1°; Beta angle, 30.1 ± 2.5°), and incisor inclination was within normal limits (interincisal angle, 131.0 ± 2.3°). Both maxillary and mandibular lengths were normal (Co–Gn, 110.0 ± 1.2 mm; ANS–PNS, 50.03 ± 2.40 mm) (Table 4). Comparative analysis between groups did not reveal statistically significant differences; however, the results approached statistical significance ($p > 0.05$). This may be attributable to the relatively small sample size.

DISCUSSION

Examination of students from the Saint Petersburg Cadet Military Corps named after Prince Alexander Nevsky, a general education institution of the Ministry of Defense of the Russian Federation, revealed pronounced facial and dentoalveolar abnormalities of the craniofacial complex. These findings are consistent with the observations of Mew [3], who reported that mouth breathing leads to compensatory forward head posture aimed at enlarging the upper airway lumen. Prolonged and persistent head inclination results in increased load on the upper back musculature, with cervical and lumbar lordosis, anterior shoulder posture, posterior scapular displacement, anterior pelvic tilt, and descent of the hyoid bone [25].

Furthermore, disruption of myodynamic balance caused by mouth breathing resulted in a class II malocclusion according to Angle in all cadets of group 1

Table 2. Results of intraoral clinical examination in cadets aged 13–15 years (*n*/%)

Type of dentofacial anomaly	Habitual occlusion	Class II malocclusion	Anterior crowding	Anterior open bite	Unilateral crossbite	Bilateral crossbite
Group 1	—	30/100	28/93.3	17/56.7	9/30.0	4/13.3
Group 2	30/100	—	2/6.7	—	—	—

Table 3. Results of biometric measurements on 3D control and diagnostic models of the first and second groups, mm (M±m)

Groups	Maxilla				Mandible			
	Anterior premolar width (SI_1) and posterior molar width (SI_2) of the arches according to Pont's method							
	SI_1	Predicted value ($SI_1 \times 1.25$)	SI_2	Predicted value ($SI_2 \times 1.54$)	SI_1	Predicted value ($SI_1 \times 1.25$)	SI_2	Predicted value ($SI_2 \times 1.54$)
Group 1	34.5 ± 2.4	39.5 ± 3.2	43.0 ± 2.1	46.5 ± 3.1	36.5 ± 2.3	39.5 ± 3.2	43.6 ± 3.1	46.5 ± 3.1
Group 2	40.1 ± 2.5	40.4 ± 3.1	44.3 ± 2.2	45.4 ± 3.4	34.5 ± 2.8	40.4 ± 3.1	45.6 ± 3.2	45.4 ± 3.4

Note. Probability of error-free prediction $p > 0.05$.

Table 4. Results of three-dimensional cephalometric analysis, degrees (M±m)

Parameters	Group 1	Group 2
∠SNA, °	82.5±1.7	81.4±2.1
∠SNB, °	75.4±2.8	79.8±1.6
∠ANB, °	6.6±2.4	2.3±1.1
∠Beta, °	24.7±3.1	30.1±2.5
∠U1–L1, °	126.0±3.4	131.0±2.3
Co–Gn, мм	106±2.3	110±1.2
ANS–PNS, мм	50.03±2.40	48.3±2.2

Note. Probability of error-free prediction $p > 0.05$.

(100%), with vertical open bite (56.7%), posterior crossbite (76.0%), and anterior crowding (93.3%) due to maxillary and mandibular constriction. A 2020 study by Sokolovich et al. demonstrated that anterior crowding in both arches creates favorable conditions for plaque accumulation and increases the risk of initiation and progression of enamel caries. This not only affects the patient's esthetics but also increases the demand for dental care [26].

Anterior crowding and posterior crossbite are primarily associated with transverse discrepancies. Biometric measurements of 3-dimensional diagnostic models showed that cadets with mouth breathing exhibited maxillary and mandibular constriction in both premolar and molar regions. These results are consistent with our earlier study [16], which also demonstrated constricted dental arches in patients with Class II malocclusion. Such constriction explains mandibular retroposition, as a narrowed maxilla—particularly in the molar region—prevents the mandible from assuming its correct anterior position and completing normal growth.

Three-dimensional cephalometric analysis revealed mandibular retroposition in cadets with mouth breathing (SNB, 75.4 ± 2.8°). These findings are supported by Peltomäki et al. (2007), who reported that mouth breathing is associated with impaired mandibular growth and retroposition, linked to altered nocturnal secretion of growth hormone (somatotropin) [27]. Moreover, studies by Mattar et al. (2011, 2012) demonstrated that in children aged 3–6 years, restoration of nasal breathing via adenotonsillotomy led to significant normalization of mandibular growth direction and inclination, as well as an increase in posterior facial height within 28 months postoperatively [28, 29].

It is important to note that mandibular retroposition associated with mouth breathing is accompanied by a reduction in upper airway volume [30], which represents a significant risk factor for the future development of obstructive sleep apnea syndrome [31].

Thus, mouth breathing should be regarded as a risk factor for the development of skeletal Class II malocclusion, alongside deleterious oral habits (e.g., digit sucking, tongue interposition between dental arches), as well as fetal alcohol syndrome and preterm birth [5].

The present findings emphasize the need for implementation of preventive programs during the critical stages of dentofacial development, as well as the importance of early diagnosis and elimination of upper airway obstruction with the involvement of otorhinolaryngologists. Such measures would reduce the risk of skeletal Class II malocclusion, prevent progression from dentoalveolar to skeletal malocclusion, and minimize relapse following orthodontic treatment.

CONCLUSION

In students of general education institutions of the Ministry of Defense of the Russian Federation with mouth breathing caused by partial or complete upper airway obstruction, pronounced dentoalveolar and skeletal abnormalities were identified: constricted maxillary and mandibular arches, bimaxillary incisor protrusion, mandibular retroposition, and Angle Class II malocclusion (Disto-occlusion).

At school admission and during annual medical examinations, dentists should evaluate the patency of the upper airway. Early identification of mouth breathing will help prevent the development of dentofacial anomalies.

For effective preventive and therapeutic management—both at the diagnostic stage and throughout orthodontic treatment—a multidisciplinary approach is advisable, involving simultaneous collaboration with an otorhinolaryngologist.

ADDITIONAL INFORMATION

Funding sources: The authors report no external funding for this study or its publication.

Conflict of interests: The authors declare no explicit or potential conflicts of interests associated with the study and publication of this article.

Author contributions: All authors affirm their compliance with the international ICMJE criteria (all authors made substantial contributions to the conceptualization, research, and manuscript preparation, and reviewed and approved the final version prior to publication). The largest contribution is distributed as follows: N.A. Sokolovich—research methodology and design; A.A. Saunina, V.V. Dvoryanchikov—collection and analysis of literary sources, statistical analysis of the data obtained; A.A. Lunev—collection of primary analytical data; I.K. Soldatov, O.S. Donskaya—writing, editing and graphic design of the article text.

REFERENCES

1. Moss ML, Salentijn L. The capsular matrix. *Am J Orthod*. 1969;56(5):474–490. doi: 10.1016/0002-9416(69)90209-7

2. Zicari AM, Albani F, Ntrekou P, et al. Oral breathing and dental malocclusions. *Eur J Paediatr Dent*. 2009;10(2):59–64.

3. Myu D. *Malocclusion of the Teeth: Orthotropic Approach*. Moscow: TARKOMM; 2018. 247 p. (In Russ).

4. Souki BQ, Pimenta GB, Souki MQ, et al. Prevalence of malocclusion among mouth breathing children: do expectations meet reality? *Int J Pediatr Otorhinolaryngol*. 2009;73(5):767–773. doi: 10.1016/j.ijporl.2009.02.006

5. Petrova NP, Saunina AA, Sokolovich NA, Sverdlova SV. *Harmful Habits of Children in Orthodontic Practice.* Saint Petersburg: LLC "Chelovek"; 2022. 84 p. (In Russ). EDN: ZYMTLK

6. Sano M, Sano S, Oka N, et al. Increased oxygen load in the prefrontal cortex from mouth breathing: a vector-based near-infrared spectroscopy study. *Neuroreport.* 2013;24(17):935–940. doi: 10.1097/WNR.0000000000000008

7. Fensterseifer GS, Carpes O, Weckx LL, Martha VF. Mouth breathing in children with learning disorders. *Braz J Otorhinolaryngol.* 2013;79(5):620–624. doi: 10.5935/1808-8694.20130111

8. Kryukov EV, Zhdanov KV, Kozlov KV, et al. Electron microscopic changes in the nasal membrane of patients with covid-19 depending on the clinical form and the period of the disease. *Jurnal infektologii*. 2021;13(2):5–13. EDN: UYWDWK doi: 10.22625/2072-6732-2021-13-2-5-13

9. Gorokhov AA, Dvoryanchikov VV, Mironov VG, Panevin PA. Occurrence of sanitary ear nose throat losses. *Bulletin of the Russian Military Medical Academy*. 2013;41(1):170–173. EDN: QBGDZD

10. Dvoryanchikov VV, Grebnev GA., Isachenko VS, Shafigullin AV. Odontogenic maxillary sinusitis: current state of the problem. *Bulletin of the Russian Military Medical Academy*. 2018;64(4):169–173. EDN: YOIRQL doi: 10.17816/brmma12341

11. Dvoryanchikov VV, Grebnev GA, Balin VV, Shafigullin AV. Complex treatment of odontogenic maxillary sinusitis. *Clinical Dentistry (Russia)*. 2019;(2):65–67. EDN: SEBCAP doi: 10.37988/1811-153X_2019_2_65

12. Pavlova SS, Korneenkov AA, Dvoryanchikov VV, et al. Assessment of population health losses due to nasal obstruction based on the concept of global burden of disease: general approaches and research directions. *Medical Council*. 2021;(12):138–145. EDN: TRFQNY doi: 10.21518/2079-701X-2021-12-138-145

13. Sevryukov F, Malinina O, Elina Yu. Peculiar features of morbidity of the population with disordes of the genitourinary sistem and diseases of the prostate gland, in particular, in the Russian Federation, in the Privolzhsky (Volga) Federal District, and in the Nizhni Novgorod region. *Social Aspects of Population Health*. 2011;(6):8. EDN: OPGNQF

14. Kadyrov ZA, Faniev MV, Prokopyev YV, et al. Reproductive health of the Russian population as a key factor in demographic dynamics. *The Bulletin of Contemporary Clinical Medicine*. 2022;15(5):100–106. EDN: FPJIAU doi: 10.20969/VSKM.2022.15(5).100-106

15. Agarwal R, Sharma L. Comparison of different angular measurements to assess sagittal Jaw discrepancy in Jaipur population — a cephelometric study. *IOSR Journal of Dental and Medical Sciences*. 2013;10(1):33–36. doi: 10.9790/0853-1013336

16. Sokolovich NA, Saunina AA, Mikhailova ES, Soldatov IK. Evaluation of dental anomalies in pupils of educational institutions of the ministry of defense of Russia and its impact on the level of anxiety. *Medico-Biological and Socio-Psychological Issues of Safety in Emergency Situations*. 2022;(4):58–64. EDN: RGFWFC doi: 10.25016/2541-7487-2022-0-3-58-64

17. Certificate of state registration of the database RU 2023624691. Soldatov IK, Makiev RG, Arsentev VG, Soldatov AN. *Indicators of somatic health and morbidity among students enrolled in general education institutions of the Ministry of Defense of Russia for the years 2009–2022.* Published 18/12/2023. (In Russ). EDN: JSFTMF

18. Soldatova LN, Iordanishvili AK. Occurrence of dentoalveolar anomalies in young men residing in megalopolis and its suburbs. *Kursk Scientific and Practical Bulletin Man and His Health*. 2016;(2):45–49. EDN: WDNGCX doi: 10.21626/vestnik/2016-2/08

19. Iordanishvili AK, Soldatova LN. Description and features of the bite in applicants of higher military educational institutions. *Journal of Volgograd State Medical University*. 2016;(3):55–57. EDN: WMIDWR

20. Soldatova LN, Iordanishvili AK, Kerimkhanov KA. Orthodontic help to cadets of highest military educational institutions: challenges and future trends. *Kursk Scientific and Practical Bulletin Man and His Health*. 2016;(2):16–19. EDN: WDNGAF doi: 10.21626/vestnik/2016-2/03

21. Iordanishvili AK, Soldatova LN. Stomatological health of the military men and their needs in the dentoprosthetic and orthodontic assistance. *Bulletin of the Russian Military Medical Academy*. 2016;(4):36–38. EDN: XHUBHB

22. Certificate of state registration of the database RU 2023622392. Soldatov AN, Soldatov IK, Grebnev GA, Kovalchuk SV. *Database of the dental health status of students in general education institutions of the Ministry of Defense of Russia.* Published 13/07/2023. (In Russ). EDN: XRDLVE doi: 10.17816/dent626305

23. Pont A. The tooth index in orthodontics. *Zeitschrift Zahnärztl Orthopäde.* 1909;(3):306–321. (In Germany).

24. Minaev YuL, Kuvakin VI, Zubov NN, et al. *Economic-mathematical methods of modeling and data analysis (using the example of solving specific problems in dentistry)*. Moscow: Limited Liability Company "Publisher" Mir nauki"; 2019. (In Russ). EDN: BHMZEH

25. Denotti G, Ventura S, Arena O, Fortini A. Oral breathing: new early treatment protocol. *J Pediatr Neonat Individual Med*. 2014;3(1):e030108.

26. Sokolovich N, Petrova NP, Grigoriev IV, et al. The change of volume, pH and microbiota of unstimulated oral fluid of oral cavity during orthodontic treatment with fixed appliances. *International Journal of Pharmaceutical Research*. 2020;12(3):638–642. EDN: ZCBDQU doi: 10.31838/ijpr/2020.12.03.093

27. Peltomäki T. The effect of mode of breathing on craniofacial growth — revisited. *Eur J Orthod.* 2007;29(5):426–429. doi: 10.1093/ejo/cjm055

28. Mattar SE, Valera FC, Faria G, et al. Changes in facial morphology after adenotonsillectomy in mouth-breathing children. *Int J Paediatr Dent*. 2011;21(5):389–396. doi: 10.1111/j.1365-263X.2011.01117.x

29. Mattar SE, Matsumoto MA, Valera FC, et al. The effect of adenoidectomy or adenotonsillectomy on occlusal features in mouth breathing preschoolers. *Pediatr Dent*. 2012;34(2):108–112.

30. Saunina AA. *Clinical justification of the airway assessment method in orthodontic patients* [dissertation]. Saint Petersburg; 2023. (In Russ). EDN: BJHWUY

31. Alves PV, Zhao L, O'Gara M, et al. Three-dimensional cephalometric study of upper airway space in skeletal class II and III healthy patients. *J Craniofac Surg*. 2008:19(6):1497–1507. doi: 10.1097/SCS.0b013e31818972ef

СПИСОК ЛИТЕРАТУРЫ

1. Moss M.L., Salentijn L. The capsular matrix // Am J Orthod. 1969. Vol. 56, N 5. P. 474–490. doi: 10.1016/0002-9416(69)90209-7

2. Zicari A.M., Albani F., Ntrekou P., et al. Oral breathing and dental malocclusions // Eur J Paediatr Dent. 2009. Vol. 10, N 2. P. 59–64.

3. Мью Д. Мальокклюзия зубов: ортотропический подход. Москва: ТАРКОММ, 2018. 247 с.

4. Souki B.Q., Pimenta G.B., Souki M.Q., et al. Prevalence of malocclusion among mouth breathing children: do expectations meet reality? // Int J Pediatr Otorhinolaryngol. 2009. Vol. 73, N 5. P. 767–773. doi: 10.1016/j.ijporl.2009.02.006

5. Петрова Н.П., Саунина А.А., Соколович Н.А., Свердлова С.В. Вредные привычки детей в ортодонтической практике. Санкт-Петербург: ООО «Человек», 2022. 84 с. EDN: ZYMTLK

6. Sano M., Sano S., Oka N., et al. Increased oxygen load in the prefrontal cortex from mouth breathing: a vector-based near-infrared spectroscopy study // Neuroreport. 2013. Vol. 24, N 17. P. 935–940. doi: 10.1097/WNR.0000000000000008

7. Fensterseifer G.S., Carpes O., Weckx L.L., Martha V.F. Mouth breathing in children with learning disorders // Braz J Otorhinolaryngol. 2013. Vol. 79, N 5. P. 620–624. doi: 10.5935/1808-8694.20130111

8. Крюков Е.В., Жданов К.В., Козлов К.В., и др. Электронно-микроскопические изменения слизистой оболочки носоглотки у пациентов с COVID-19 в зависимости от клинической формы и периода заболевания // Журнал инфектологии. 2021. Т. 13, № 2. С. 5–13. EDN: UYWDWK doi: 10.22625/2072-6732-2021-13-2-5-13

9. Горохов А.А., Дворянчиков В.В., Миронов В.Г., Паневин П.А. Закономерности формирования санитарных потерь оториноларингологического профиля // Вестник Российской Военно-медицинской академии. 2013. № 1. С. 170–173. EDN: QBGDZD

10. Дворянчиков В.В., Гребнев Г.А., Исаченко В.С., Шафигуллин А.В. Одонтогенный верхнечелюстной синусит: современное состояние проблемы // Вестник Российской Военно-медицинской академии. 2018. № 4. С. 169–173. EDN: YOIRQL doi: 10.17816/brmma12341

11. Дворянчиков В.В., Гребнев Г.А., Балин В.В., Шафигуллин А.В. Комплексное лечение одонтогенного верхнечелюстного синусита // Клиническая стоматология. 2019. № 2. С. 65–67. EDN: SEBCAP doi: 10.37988/1811-153X_2019_2_65

12. Павлова С.С., Корнеенков А.А., Дворянчиков В.В., и др. Оценка потерь здоровья населения в результате назальной обструкции на основе концепции глобального бремени болезни: общие подходы и направления исследований // Медицинский совет. 2021. № 12. С. 138–145. EDN: TRFQNY doi: 10.21518/2079-701X-2021-12-138-145

13. Севрюков Ф.А., Малинина О.Ю., Елина Ю.А. Особенности заболеваемости населения Нижегородской области, Приволжского федерального округа и Российской Федерации // Социальные аспекты здоровья населения. 2011. № 6. С. 8. EDN: OPGNQF

14. Кадыров З.А., Фаниев М.В., Прокопьев Я.В., и др. Репродуктивное здоровье населения России как ключевой фактор демографической динамики // Вестник современной клинической медицины. 2022. Т. 15, № 5. С. 100–106. EDN: FPJIAU doi: 10.20969/VSKM.2022.15(5).100-106

15. Agarwal R., Sharma L. Comparison of different angular measurements to assess sagittal Jaw discrepancy in Jaipur population — a cephelometric study // IOSR Journal of Dental and Medical Sciences. 2013. Vol. 10, N 1. P. 33–36. doi: 10.9790/0853-1013336

16. Соколович Н.А., Саунина А.А., Огрина Н.А., Солдатов И.К. Оценка зубочелюстных аномалий у воспитанников общеобразовательных организаций Минобороны России и ее влияние на уровень тревожности // Медико-биологические и социально-психологические проблемы безопасности в чрезвычайных ситуациях. 2022. № 3. С. 58–64. EDN: RGFWFC doi: 10.25016/2541-7487-2022-0-3-58-64

17. Свидетельство о государственной регистрации базы данных № 2023624691 РФ. Солдатов И.К., Макиев Р.Г., Арсентьев В.Г., Солдатов А.Н. Показатели соматического здоровья и заболеваемости среди воспитанников, обучающихся в общеобразовательных организациях Минобороны России за 2009–2022 годы. № 2023624375: заявл. 29.11.2023: опубл. 18.12.2023. EDN: JSFTMF

18. Солдатова Л.Н., Иорданишвили А.К. Встречаемость зубочелюстных аномалий у юношей, проживающих в мегаполисе и его регионах // Курский научно-практический вестник Человек и его здоровье. 2016. № 2. С. 45–49. EDN: WDNGCX doi: 10.21626/vestnik/2016-2/08

19. Иорданишвили А.К., Солдатова Л.Н. Характеристика и особенности прикуса у абитуриентов высших военных учебных учреждений // Вестник Волгоградского государственного медицинского университета. 2016. № 3. С. 55–57. EDN: WMIDWR

20. Солдатова Л.Н., Иорданишвили А.К. Керимханов К.А. Ортодонтическая помощь курсантам высших военных учебных учреждений: проблемы и перспективы совершенствования // Курский научно-практический вестник Человек и его здоровье. 2016. № 2. С. 16–19. EDN: WDNGAF doi: 10.21626/vestnik/2016-2/03

21. Иорданишвили А.К., Солдатова Л.Н. Стоматологическое здоровье военнослужащих и их нуждаемость в зубопротезной и ортодонтической помощи // Вестник Российской Военно-медицинской академии. 2016. № 4. С. 36–38. EDN: XHUBHB

22. Свидетельство о государственной регистрации базы данных № 2023622392 РФ. Солдатов А.Н., Солдатов И.К., Гребнев Г.А., Ковальчук С.В. База данных состояния стоматологического здоровья воспитанников общеобразовательных организаций Минобороны России. № 2023622089: заявл. 03.07.2023: опубл. 13.07.2023. EDN: XRDLVE doi: 10.17816/dent626305

23. Pont A. Der zahn-index in der orthodontie // Zeitschrift Zahnärztl Orthopäde. 1909. Vol. 3. P. 306–321.

24. Минаев Ю.Л., Кувакин В.И., Зубов Н.Н., и др. Экономико-математические методы моделирования и анализа данных (на примере решения частных задач в стоматологии). Москва: Общество с ограниченной ответственностью «Издательство «Мир науки»», 2019. EDN: BHMZEH

25. Denotti G., Ventura S., Arena O., Fortini A. Oral breathing: new early treatment protocol // Journal of Pediatric and Neonatal Individualized Medicine. 2014. Vol. 3, N 1. P. e030108.

26. Sokolovich N., Petrova N.P., Grigoriev I.V., et al. The change of volume, pH and microbiota of unstimulated oral fluid of oral cavity during orthodontic treatment with fixed appliances // International Journal of Pharmaceutical Research. 2020. Vol. 12, N 3. P. 638–642. EDN: ZCBDQU doi: 10.31838/ijpr/2020.12.03.093

27. Peltomäki T. The effect of mode of breathing on craniofacial growth — revisited // Eur J Orthod. 2007. Vol. 29, N 5. P. 426–435. doi: 10.1093/ejo/cjm055

28. Mattar S.E., Valera F.C., Faria G., Matsumoto M.A., Anselmo-Lima W.T. Changes in facial morphology after adenotonsillectomy in

mouth-breathing children // Int J Paediatr Dent. 2011. Vol. 21, N 5. P. 389–396. doi: 10.1111/j.1365-263X.2011.01117.x
29. Mattar S.E., Matsumoto M.A., Valera F.C., et al. The effect of adenoidectomy or adenotonsillectomy on occlusal features in mouth breathing preschoolers // Pediatr Dent. 2012. Vol. 34, N 2. P. 108–112.
30. Саунина А.А. Клиническое обоснование способа оценки состояния дыхательных путей у ортодонтических пациентов: дис. ... канд. мед. наук. Санкт-Петербург, 2023. EDN: BJHWUY
31. Alves P.V., Zhao L., O'Gara M., et al. Three-dimensional cephalometric study of upper airway space in skeletal class II and III healthy patients // J Craniofac Surg. 2008. Vol. 19, N 6. P. 1497–1507. doi: 10.1097/SCS.0b013e31818972ef

AUTHORS' INFO

*** Ivan K. Soldatov,** MD, Cand. Sci. (Medicine), Associate Professor; address: 6 Academica Lebedeva street, 194044 Saint Petersburg, Russia;
ORCID: 0000-0001-8740-9092;
eLibrary SPIN: 1503-1278;
e-mail: ivan-soldatov@mail.ru

Natalia A. Sokolovich, MD, Dr. Sci. (Medicine), Professor;
ORCID: 0000-0002-5621-7247;
eLibrary SPIN: 1017-8210;
e-mail: lun_nat@mail.ru

Anastasiya A. Saunina, MD, Cand. Sci. (Medicine);
ORCID: 0000-0002-0328-2248;
eLibrary SPIN: 4607-1198;
e-mail: s4unina@yandex.ru

Vladimir V. Dvoryanchikov, MD, Dr. Sci. (Medicine), Professor;
ORCID: 0000-0002-0925-7596;
eLibrary SPIN: 3538-2406;
e-mail: 3162256@mail.ru

Anatoli A. Lunev;
ORCID: 0000-0001-7616-6144;
eLibrary SPIN: 1868-3027;
e-mail: luniov2015@yandex.ru

Olga S. Donskaya, MD, Cand. Sci. (Medicine);
ORCID: 0000-0002-3477-2987;
eLibrary SPIN: 1713-9441;
e-mail: olia.kafedra.psz@yandex.ru

* Corresponding author / Автор, ответственный за переписку

ОБ АВТОРАХ

*** Солдатов Иван Константинович,** канд. мед. наук, доцент; адрес: Россия, 194044, Санкт-Петербург, ул. Академика Лебедева, д. 6;
ORCID: 0000-0001-8740-9092;
eLibrary SPIN: 1503-1278;
e-mail: ivan-soldatov@mail.ru

Соколович Наталия Александровна, д-р мед. наук, профессор;
ORCID: 0000-0002-5621-7247;
eLibrary SPIN: 1017-8210;
e-mail: lun_nat@mail.ru

Саунина Анастасия Андреевна, канд. мед. наук;
ORCID: 0000-0002-0328-2248;
eLibrary SPIN: 4607-1198;
e-mail: s4unina@yandex.ru

Дворянчиков Владимир Владимирович, д-р мед. наук, профессор;
ORCID: 0000-0002-0925-7596;
eLibrary SPIN: 3538-2406;
e-mail: 3162256@mail.ru

Лунев Анатолий Анатольевич;
ORCID: 0000-0001-7616-6144;
eLibrary SPIN: 1868-3027;
e-mail: luniov2015@yandex.ru

Ольга Сергеевна Донская, канд. мед. наук;
ORCID: 0000-0002-3477-2987;
eLibrary SPIN: 1713-9441;
e-mail: olia.kafedra.psz@yandex.ru