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CLINICAL DIAGNOSTIC FUNDAMENTALS OF DENTAL CARE AND ITS ROLE IN COMPLEX PROPHYLAXIS OF MAXIOFACIAL ANOMALY IN CHILDREN

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INTRODUCTION

Relevance of the research

High incidence of malocclusion amongst the population is a major problem of modern clinical orthodontics, as well as an important criteria for assessing the prophylaxis system's quality. Malocclusion is also common in children, taking second place after dental caries and its complications [6, 7, 8, 9, 12, 44, 93, 119, 171]. Moreover, most authors admit steady increase of the incidence level [146, 147, 249].

In daily clinical practice high incidence of dentofacial anomalies is further complicated by orthodontists' understaff [25, 45, 106, 110, 141] and inadequate promotion of healthy lifestyle [24, 135], as well as insufficient level of communication between related professionals [66].

Analysis of relevant literature about dentofacial anomalies shows that incidence remains high and stable in different age groups and tends to keep rising. According to Y. M. Maygin [64], anomalies' manifestations are found in 33.1% in patients with temporary bite, and 41.5% in patients with permanent bite. Study by R.M. Zvolinskaya [40] arrived to comparable results at 24% and 36% respectively. According to A.S. Sherbakov [138] and R. Frankel [183], dentofacial anomalies remain one of the most common causes of dentofacial system's dysfunction.

Clinical experience suggests the positive correlation between the child's age and the number of bite anomalies [33, 109]. Some anomalies disappear during the bite change period or transform, sometimes resulting in a more complicated form of anomaly. According to S. Hensel [192], only 17.7% cases of occlusion pathology are solved by autoregulation in longitudinal observation of children.

Mass indexation of risk groups – children and teenagers – is an important evaluation tool for anomalies' incidence and population's provision with orthodontic help used in European clinical practice. There are few indexes most mentioned in the literature [159]: IOTN – Index of Orthodontic Treatment Need, ICON – Index of Complexity, Outcome, and Need, DAI – Dental Aesthetic Index [137]. Despite many evaluation methods, no ultimate one was agreed upon yet [145].

Another important cause of malocclusions is the lack of dental literacy and awareness in populous. According to numerous authors [19], mere 41.7% of children visit commercial dental clinics at least twice a year, and 22.2% have two annual visits to municipal dental clinics. A collection of reports published by 8 EU countries in 2009-2012 [194] state that the level of dental literacy positively correlates with overall education level in the region (according to International Classification of Education, 2011). Therefore, the problem is more prominent in regions with prevailing rural residents (25.34% of Russian population, according to Rosstat as of 29.02.2020). There are certain groups of risk in urban areas as well, mainly people of low social status (which implies low subjective self-estimation of social status, low education level, low income), as well as people with deteriorating health (assessed based on the subjective estimation of one's health, limitations caused by health problems and long-term health conditions).

High malocclusion incidence and limited amount of scientifically proven clinical and prophylactic action towards decreasing it define the relevance of current research.

Goal of the research.

Rationalizing the necessity to improve dental health of children with dentofacial anomalies by the development and practical implementation of prophylaxis program.

Main objectives of the research:

1. Evaluate dynamics of dentofacial anomalies' incidence in children and teenagers of different age in two studied regions (Tyumen and Saint-Petersburg), determine the effect etiologic factors have on the development and progression of dentofacial anomalies.

2. Perform comparative analysis of current dental prophylactic programs for malocclusion and identify most prospective ways of their implementation.

3. Uncover tendencies in incidence rate of dentofacial anomalies using ICON index.

4. Assess the level of sanological knowledge of dentofacial anomalies in parents and their children in the setting of a major industrial city. Identify views and attitudes of

both groups on orthodontic treatment and discover factors leading to its abortion. Collect and analyze feedback from orthodontist on the prophylaxis program.

5. State and justify the necessity of developing and implementing prophylaxis program in routine dental practice.

Scientific novelty

Empirical evidence gained during the research allowed us to achieve numerous results:

- incidence levels of various forms of dentofacial anomalies amongst school students in Tyumen and Saints-Petersburg were compared;
- the number of children who were undergoing treatment during the study was established, as well as the number of children who required said treatment in both studied cities;
- parents' and children's attitude to received orthodontic help was studied, which led to determination and evaluation of factors affecting their choice to start the treatment;
- the degree of preparation and motivation of children and parents for the upcoming orthodontic treatment was established;
- the relationship between the prevalence of malocclusions and the level of insolation was analyzed;
- clinical recommendations for orthodontic treatment of children in regions with a lack of solar radiation have been compiled.

Theoretical and practical significance of the research

The data we acquired as the result of studying orthodontic status of examinees, incidence of various forms of occlusion anomalies, gender- and age-related features of malocclusions, level of population awareness of said pathology, basics of dental help and prophylaxis, adequacy of available treatment and diagnostics on early stages of malocclusions, became the foundation for creating and implementing a complex of activities aimed at increasing the effectiveness and quality of specialized orthodontic

preventive treatment, as well as increasing its availability, thus leading to better dental health overall.

Study results outline the necessity of implementing innovative multi-level program of dentofacial anomalies' treatment in children in practical healthcare, which should include not only the integration of related specialists and different methods of prophylactic and hygienic education, but also clinical observation and specialized treatment techniques which could be implemented on numerous levels (children clinics, families, schools and kindergartens) with proper participation from teachers, tutors and various medical specialists.

Research methods

This dissertation research is based on the methodology of a systemic approach, which involves studying the selected topic as a complex of interwoven elements. In preparation for the empirical study, a significant amount of scientific literature was analyzed, which made it possible to establish the topic's relevance and the degree of how well researched it is, as well as to determine the study concept, both the subject and the object of research.

The collection of empirical data was carried out using clinical and sociological methods, namely single-center, linear, cohort, and retrospective studies, including a randomized controlled trial. At the data analysis stage, statistical tools were used. Substantive conclusions were formulated based on general scientific methods: analysis, synthesis, induction, deduction, classification, generalization, analogy, etc.

Research results validation and practical application

The work was carried out with the assistance of the Department of Dentistry of the Faculty of Dentistry and Medical Technologies of the Federal State Budgetary Educational Institution 'St. Petersburg State University' and is fully consistent with the main direction of the department, which is 'Prevention and Epidemiology of Dental Diseases'. The results of the study were introduced into the study routine of the Department of Dentistry of the St. Petersburg State University, as well as are practically applied in the Regional Hospital No. 19 of Tyumen, the City Children's Dental Clinic No. 6 of St. Petersburg and 'Estetik' LLC of Tyumen.

The area and methods of research, scientific provisions of the dissertation work fall under the specialty ‘Dentistry’ and correspond to paragraphs 7 and 8 of specialty passport 3.1.7 – Dentistry.

The results of our study are reflected in the materials of numerous conferences and symposiums in which the author took part:“Modern medicine: current issues”, XLI International Correspondence Scientific and Practical Conference, Novosibirsk, SiBAK, 2015; “Innovations in science: XLVII international correspondence scientific and practical conference, Novosibirsk: SibAK, 2015; “Modern medicine: current issues”, LXV international correspondence scientific and practical conference, Novosibirsk: SibAK, 2017; “Current issues in pediatric dentistry. 1st All-Russian Scientific and Practical Conference", Kazan: Kazan State Medical University, 2018; “Current problems of dentistry” IV International Symposium, St. Petersburg, September 14–15, 2018; "Lomonosov-2018: international scientific conference of students, graduate students and young scientists", Moscow, April 12-13, 2018; “Innovative approaches to education, science and practice in dentistry: Krasnoyarsk, May 29-31, 2019.

Data collection methods and the degree of results credibility

The credibility of the scientific provisions is ensured by several conditions we aimed to meet. Those include the accordance between the methodology used in the research and the commonly accepted methodology reflected in the scientific literature. The research hypothesis is based on known, empirically verifiable facts and is fully consistent with the results of other studies published in sources on this topic. The validity of the obtained empirical data is ensured by scientifically based procedures for selecting subjects, as well as by the adequacy of the sample size. The validity of our conclusions is ensured by using a proven mathematical application for data processing and analysis, adopted in sanitary statistics. The technical side of the study was carried out using the R software environment, the statistical package IBM SPSS Statistics 22, as well as the standard Microsoft Office 365 package for the Windows OS.

Personal contribution of the author

The author directly and actively participated in planning and writing the dissertation, analyzed relevant scientific literature, designed a research toolkit required for the clinical study and questionnaires for examinees and their parents. The author also took part in clinical examinations and conducted surveys with children's representatives. Furthermore, he performed analysis and interpretation of all the collected data.

Relevant publications by the author

On the topic of the dissertation, 15 articles were published in total. 3 articles were published in peer-reviewed journals from the Higher Attestation Commision list, 2 – in peer-reviewed journals indexed in SCOPUS, and remaining were published in journals indexed in the RSCI.

Structure and scope of the research

The total volume of the dissertation is 252 pages. The work includes 4 chapters. Bibliography includes 267 sources, including 141 Russian and 126 foreign ones.

Main scientific results

1. 1874 children were examined during the study in Tyumen and St. Petersburg, and the prevalence of various forms of dental anomalies in the study group was compared. It was revealed that the prevalence of occlusion anomalies of various forms in Tyumen was 56.8% and 63.8% in St. Petersburg [126, P. 15; P. 75; P. 77; P. 79; P. 168]

2. The number of children undergoing treatment during the study was determined – 23.3% of children with malocclusions in Tyumen (549 people) and 35.2% of children with malocclusions in St. Petersburg (578 people) – as well as the number of schoolchildren who required orthodontic care in these cities (76.7% in Tyumen and 64.8% in St. Petersburg) [134, P. 74; P. 75; P.77; P.83]. Furthermore, an index assessment of the occlusion anomalies' severity was performed using the ICON method during the study, which revealed the following results: the coefficient of 31.34 in St. Petersburg and 34.27 in Tyumen. Both results indicate a moderate severity of the pathological process in these regions. [133, P. 56; P. 59; P. 89; P. 170].

3. Levels of preparedness and motivation for the upcoming orthodontic treatment of the examined children and their parents were established: 70.2% out of 423 children were ready to start orthodontic treatment and 91.7% of 411 parents were ready for long-term treatment. However, only 25.5% of parents were ready to for the expensive treatment. The attitude of both parents and children to receiving the orthodontic treatment was studied: factors influencing the decision to begin treatment were identified and assessed. 41.6% of children were aware of their problematic bite, and 32.9% encountered difficulties while communicating with peers due to occlusion anomalies. As for the parents and children's representatives, main motivational factors for starting treatment were the cost of treatment and the level of their awareness about the prevention of malocclusions [132, P. 151; P.164; P.167].

4. An analysis of the relationship between the prevalence of malocclusions and the level of insolation was performed during the study. However, no clear connection between the two was discovered, despite high frequency of malocclusions in both cities. [126, P. 75; P. 77]

5. We have designed clinical recommendations for orthodontic treatment of children in Tyumen and St. Petersburg, including clinical guidelines not only for diagnostic appointments and preparing the patient for orthodontic treatment (including both dental sanitation and preparation of soft tissues of the oral cavity for orthodontic treatment), but also regarding cooperation with doctors and specialists in other areas (otorhinolaryngologists, osteopaths, pediatricians, speech therapists, educators, etc.) [168, P. 37; P. 113; P. 114 – 25% personal participation in writing the article, 100% – English translation of the article].

Defense provisions

1. As a result of the analysis of the malocclusion incidence in preschoolers and children of primary and secondary school age in the cities of St. Petersburg and Tyumen, we discovered that the higher severity of some forms is a results of a combination of negative medical and social factors associated with age, gender, the prevalence of dental caries, and deficiencies in the organization of orthodontic treatment.

2. Index assessment of individual patients or their respective groups makes it possible to assess the severity and course of the disease on both individual and population levels.

3. Participants in the treatment of malocclusion pathology include parents, children, orthodontists and dentists. Identifying readiness and attitude towards the treatment and prevention of dental anomalies is crucial in order to increase the motivation of all those participants to improve the current situation with bite pathology and its consequences.

4. Separate programs for the prevention of malocclusions do not exist currently. Preventive measures are most effective in the early stages of development of the child's dentofacial area, so it is advisable to begin their implementation even prior to the formation of a temporary bite. Prevention should be carried out on an interdisciplinary basis.

CHAPTER 1. LITERATURE REVIEW

1.1. Incidence of different forms of occlusion anomalies

Dental health is an important indicator of overall health tightly linked to the quality of life, which correlates with WHO definition of health as a state of full physical, mental and social well-being. Many definitions of 'dental health' could be found during literature analysis. Some authors [17] define it as a certain state of maxillofacial region in which no pathological or aesthetic problems are present, and basic speech reproduction and chewing are intact. Y.L. Obraztsov (2007) gives another definition: dental health is a combined total of aesthetic, clinical, morphological and functional criteria of dentofacial system, allowing for psychological, emotional and physical well-being [75]. WHO published a fundamental document 'Global goals for dental health improvement in different population groups before 2020', which suggests prioritizing the reduction of impact dental pathologies have on overall health and minimizing manifestations of somatic oral conditions [42]. Notably, dental health could also imply harmoniously developed dentofacial system, which is balanced in its functionality and is able to remain sustainable under the influence of outer and inner factors in case of no present pathology [70]. Research object is malocclusion in preschoolers and teenagers, its incidence and means of prophylaxis.

Malocclusion is a state of dentofacial system in which it is unable to function properly due to the lack of multiple points of teeth contact and the presence of hinderances during the switch between one type of occlusion into the other. Studying incidence of the malocclusion has high priority due to it being on top of the list of dental healthcare pathologies both preschoolers and teenagers, and adults.

According to Y.L. Obraztsov's study of 5299 cases (children aged 3-14 years), incidence of dentofacial anomalies was 42.7 ± 0,6 % – 40.1 ± 1.1 % for preschoolers and 43.8 ± 0.8 % for teenagers. Teeth anomalies were present in 0.7 % of examinees, 14.7% had dentition anomalies and 27.3 % had malocclusion [75].

Further epidemiologic studies in different cities and regions of Russian Federation (2001) showed no tendency in decrease of said anomalies. According to

Obraztsov, there was a 24.5% increase in occlusion anomalies in preschoolers and teenagers during the last 20-year period [75].

Various studies revealed high and, unfortunately, stable incidence in malocclusion.

According to Vakushina E.A. et al. (2003) [22], malocclusion is present in 58.98 ± 2.75 % of population in Sevastopol, both children and adults.

Teperina I.M. [112] carried out study in Tver in 2008, which revealed the total incidence of 74.9% in children: 82% in children aged 6-9 years and 72.3% in those aged 10-12 years. Those changes suggest autoregulation of the malocclusion due to physiological factors, namely age-related hormonal spikes. Fares I.M. [118] discovered that 58.3% children of Baku have dental-maxillo-facial anomalies (DMFA); furthermore, incidence varied based on where those children lived, being 34.1% for those who lived in the city center, and 24.1% for those living closer to the outskirts. These results are interesting and important as they demonstrate correlation between DMFA incidence and socio-economic conditions children live in.

Studies carried out by A.I. Manin [65] in Moscow, Orel and Elista revealed DMFA incidence levels of 81.1%, 79.6% and 89% respectively in children aged 7-11 years. Analogous study in Sevastopol have shown 51.6% prevalence of jaw size anomaly with crowded teeth and 30.6% prevalence of distal occlusion [22].

T.F. Vinogradova's study in Moscow region discovered that 90% of preschoolers have various occlusion pathologies, and about 50% require serious orthodontic treatment [23]. This statistic represents all cases of occlusion anomalies found by author, including mild rotation and teeth crowding. Notably, despite that inclusion, the study evidently shows how massive the issue is for children from various regions of Russian Federation.

A.G. Korenev's research [53], based on massive study of preschoolers and teenagers, and comparison with previous studies in the same region (Minsk and Minskaya oblast, Belarus), revealed medium and high levels of orthodontic pathology being present in children who live in cities (71.94%) and in rural areas (49.25%).

Another noteworthy study was carried out in the Ukraine, in regions with increased concentration of fluoride in the drinking water [69]. Authors examined children from numerous cities from the western part of the country – namely Sosnovka, Chervonograd and Dobrotvor, and disc bovered high DMFA incidence – 73.69%, 69.04% and 70.89% respectively. Analysis of that study revealed that most common occurrence was children with deep (16.7%) and distal (13.32%) occlusion, while open and mesial occlusions were diagnosed less frequently – 7.35% and 5.37% respectively. Anomalies in the transversal plane were found in 11.53% cases, and, notably, mere 3.58% of children overwent orthodontic treatment. Thus, the study had overall shown high incidence of occlusion anomalies; however, due to the lack comparison with other regions (where fluoride concentrations are average or low), it is impossible to confirm any correlation between the two factors.

One should also consider a study by M. Sabashvili [253] involving children of various age in Tbilisi (Georgia). A total of 500 children were examined: 316 girls and 184 boys aged 6-15 years. Examination revealed DMFA in 69.3% of them, incisor crowding in 24.7% and neutral occlusion in 30.7%. We could yet again note high incidence of malocclusion based on this research and find author's attempt in comparative analysis of incidence to be interesting, yet lacking in firm evidence as groups were seriously uneven.

Analysis of foreign studies also confirms high DMFA incidence. One of the more prominent ones is a study by I.E. Gelgor [214], who studied teenagers of 12-16 years of age living in Central Anatolia (Turkey). Author examined 1125 boys and 1204 girls who never received any orthodontic treatment before. The study revealed 34.9% of examinees to have grade I anomaly (Black classification), and 40% to have grade II. Index of orthodontic treatment need (IOTN) was 28%.

To summarize, literature analysis of occlusion anomaly incidence both in Russia and overboard shows high rate of occurrence, which therefore requires further studies. The analysis leads to conclusion that most studies were carried out in major cities and regions and involved primarily children. However, there is a lot of data missing when it comes to rural and hard-to-reach regions with limited availability of orthodontic

treatment. It is a significant problem in of itself, which requires further investigation. Despite the low number of contemporary studies, available ones point out the decline in dentofacial system health in teenagers living in rural areas. For example, a study by Dila Baz Khan et al. included children from different socio-economic statuses living in Peshawar province (Pakistan) and had shown that children from rural areas tend to suffer more from malocclusion, as well as are less likely to receive specialized help than their peers from urban areas [203]. Several other studies from various regions support this conclusion [232, 246, 259]. We must admit that the data from different regions could be highly variable in terms of metrics, which, as we presume, is due to demographic and socio-economic features of certain regions. This further confirms the requirement for further studies of orthodontic care availability and effectiveness.

One should also mind the lack of correlation between the malocclusion incidence and either the age or the area of residence of the examinee, which suggests little to no influence of geographic factors in the development of the malocclusion, as well as little correlation with the ethnicity [126]. Numerous researchers [94, 143, 210, 211, 238] attempted to link the high incidence to various geographic and ecological factors, such as insolation levels, poor ecology in urban areas, high concentration of fluoride in the drinking water; however, in the absence of comparative study in areas with more favorable conditions, those studies are of little value.

1.2. Etiology and pathogenesis of malocclusion

Malocclusions are peculiar in terms of pathophysiology, as they are a multifaceted process with many causes [126]. Another interesting feature of malocclusions is morphologic changes occurring in tissues combined with physiological normality on the cellular level.

Obraztsov Y.L. [75] speculates the following etiologic factors of DMFA development:

- hereditary (inheriting DMFA from one of the parents; inherited transmission of jaw growth stereotype; inherited enlarged or smaller teeth not fitting jaw sizes);

- external (adverse antenatal period of pregnancy, complication during labour);

- postnatal (somatic diseases during the development – pathologies of ENT organs, endocrine disorders, malnutrition, congenital and acquired locomotor system trauma, trauma of the dentofacial system – both odontogenic and non-odontogenic, structural disorders of dentofacial system's organs and tissues, and hindered related functions, such as swallowing, sucking, breathing and speaking [129].

It is hard to verify the hereditary character of anomalies. Genetic analysis is used: its methods include genealogical, statistical, and twin studies. Genealogical method allowed to establish that the progeny in those with lower macrognathia is caused genetically, and is transmitted as a dominant trait [40, 41]. An analysis of genealogical study carried out by Abolmasov N.G. and Razumovskii L.A. (1981) [1, 2], which involved 30 examinees, revealed that in 13.3±8.3% cases one of the parents had an open bite, and in 73.1±8.8% a direct bite was present. Inheritance is undoubtedly an important factor which determines the size and the shape of teeth; however, scientists have not yet pinpointed the responsible gene. Genetic factor is polygenic and has an indirect influence on the dentofacial system's development. Certain factors also negatively affect physical development of the fetus:

- complications during pregnancy (infections during the first trimester, malnutrition, severe somatic conditions, bad habits, etc.);

- endocrine system's pathologies (hypothyroidism, malfunctions of the adenohypophysis, adrenocortical system, etc.);

- congenital heart diseases;

- severe lesions of the respiratory system, kidneys, gastrointestinal system, central nervous system, etc.;

R.R. Turaev [114] established that pregnant women with complications during pregnancy have an 82% higher chance of giving birth to a child with DMFA. The influence of endocrine factors is more traceable than that of genetic ones, due to different anomalies could be the result of certain endocrine pathologies. One of the most prominent studies are of patients with pseudohypoparathyreoidism, who also had a clear manifestation of malocclusion, as well as changes in the size and the shape of individual teeth [170].

Udovitskaya E.V. [115] noted the close connection between malocclusions and endocrine pathology in her monograph ‘Endocrinological Aspects of Dentistry’. Her work describes the relationship between hyperfunction of the anterior lobe of the pituitary gland and anomalies of individual teeth placement.

According to the observations found in numerous research, respondents with pituitary dwarfism were found to have trema, despite the small size of the jaw bones. Dysfunction of the gonads could also be linked to certain manifestations in the oral cavity. For example, hypogenitalism is associated with the crowding of teeth, anomalies in the position of individual teeth, second upper incisors, second premolars, and dystopia of the upper canines, which are all consequences of early cessation of growth of the jaw bones [115]. A certain review of studies on pathologies of the anterior pituitary gland is also of relevance. Studies of the dysfunction in the production of growth hormone suggest the influence of this pathology on the timing of teething, to the point at which this process occurs throughout the whole life of a patient. Even with the timely eruption of individual teeth, a violation of the principle of pairing was often observed due to improper development of the rudiments and delayed formation of teeth roots. Impaired timing of eruption due to growth hormone deficiency was observed by Gratkowska [187], while Park noted manifestations of prognathia due to the dysfunction of somatotropin receptors [237].

Speaking of hormonal disorders, it is worth mentioning the effect the vitamin D3 deficiency has on the development and outcome of orthodontic treatment. This hormone (1,25-dehydroxyvitamin D3) is involved in mineral homeostasis and mineral metabolism in humans. A decrease in its concentration leads to active secretion of PTH (parathyroid hormone), which in turn leads to a decrease in calcium levels. The main function of PTH in this system is regulatory, thanks to which the balance of mineral substances is maintained depending on the amount of D3 in the body. The ways in which vitamin D3 enters the body have been well studied: either endogenous synthesis by the skin under the sunray influence from its precursor 7-dehydrocholesterol or exogenous through the digestion of certain food items. It is also important to note the experimental experience of using vitamin D metabolites from the Masayoshi Kawakami

group, namely calcitirol (1,25-dehydrovitamin D3), in laboratory rats with orthodontically displaced tooth roots. Histomorphological laboratory analysis revealed that the absence of calcitirol reduced the rate of mineral apposition at the site of bone compression, while injections of this metabolite stimulated alveolar bone formation 14 days after administration [202].

After analyzing the scientific research literature, we came to the following conclusion: the prevailing part of DFA in children over three years of age has an acquired genesis. However, one of the most common causes of DFA in the population is odontogenic and non-odontogenic tooth loss. It is worth noting that in case of odontogenic etiology, the estimated risk group for developing DFA is 80%–90% of the population due to the high prevalence of caries.

Chronic periodontitis is the most common cause of early tooth loss [250]. Simultaneously, the variability of prematurely removed teeth due to odontogenic causes is, according to various sources, 21.5%–81%. According to modern clinical standards, tooth loss is labeled as ‘early’ if it occurs two years before the natural change of teeth. However, there is clinical evidence that tooth loss a year before the physiological change is more critical. Therefore, this is an interesting subject for discussion. Noteworthy, despite the period that has passed since the extraction, the loss of even one tooth often negatively affects the further development of cervical teeth. The main cause of DFA in early tooth loss is the underdevelopment of jaw bones due to the decreased activity of growth zones. Early loss of primary teeth often causes changes in tongue functionality, which reflexively compensates the dentition defect. As a result, a child develops bad habit of tongue sucking. Premature absence of the upper incisors leads to flattening of the upper lip and protrusion of the lower lip due to pressure on the lower incisors of the tongue in most cases. It can be argued that premature loss of incisors is the main cause of interdental sigmatism, a disorder of sound pronunciation, due to the incorrect position of the tongue. Premature loss of primary molars, which support the bite, leads to a decrease in bite height and distalization of the mandible.

Early loss of teeth in the primary dentition irreversibly affects the timing of the eruption of permanent teeth, namely promotes either early or delayed eruption and

affects the position of the primordia of permanent teeth. With the loss of temporary molars, the first permanent molars are repositioned and, as a result, the position of the primordia of premolars changes.

Another important etiological factor in the formation of malocclusions is the pathological act of breathing. Due to frequent colds suffered in childhood, the skill of nasal breathing is lost, and compensatory mouth breathing develops. The mouth in such a clinical situation is half-open, which over time inevitably leads to underdevelopment of the structures of the upper jaw and, consequentially, an open bite [218]. This topic is discussed extensively in the study by Nagaiwa et al. (2016) [233], in which the author found a significant decrease in chewing activity in people suffering from mouth breathing. The correlation between DFA-crossbite, open bite and pathologies of ENT organs, including oral breathing, is found in the study of A. Emmerich [258].

Amal el Aouame and Farid el Quars (Morocco) [155] compared the lateral TRGs of children with nasal breathing problems and children without them, showing significant differences in cephalometric parameters between the two. The authors highlight an increase in the vertical dimensions of the jaws, rotation of the lower jaw in the distal direction in children with mouth breathing, up to retrognathia and open bite in severe cases of apnea. This study clearly shows both the influence of general somatic pathology on the state of occlusion and proves the need for cooperation between orthodontists and general practitioners.

Amit Nagar et co. came to a similar conclusion [213], noting an increase in facial height, mandibular angle, and gonial angle in children and adolescents with mouth breathing. This indicates the need to refer to cephalometric results not only when analyzing the process and results of orthodontic treatment, but also in general somatic cases.

The problem of mouth breathing has attracted the attention of researchers for a long time and is most fully disclosed in the works of Moss M.L. According to the author's theory, normal nasal respiratory activity is a trigger for the growth of craniofascial structures of the skull [226, 227, 228, 229].

S.V. Proskokova [89] studied 501 children aged 3-16 years living in Khabarovsk and the Khabarovsk region, and her study revealed a frequency of bite pathologies of 67.09% in the studied group. The largest group consisted of children of all ages with dental anomalies (crowding of teeth) – 62.67%. An analysis of the data was carried out by the center of state sanitary and epidemiological surveillance in the Khabarovsk region in 1995–2002, and it demonstrated the structure of diseases of the examined children during the observation period. Respiratory diseases took the first place each year: their share was 47.7%-55.3%. Within the class of these diseases, 89% were acute upper respiratory tract infections, pneumonia and influenza. It was revealed that long-term disruption of nasal breathing in childhood not only had a detrimental effect on the development of the child's chest skeleton, but also caused subsequent deformation of the facial skeleton: the upper jaw developed incorrectly, its lateral parts moved closer together, and the hard palate became narrow and high. This caused a narrowing of the upper dentition and crowding of teeth in both the upper and lower jaws. Later in this chapter we will discuss the issue of the negative impact of mouth breathing and apnea on the development of anomalies of the maxillofacial area in more detail.

The relationship between the environmental disadvantage of a territory and the number of malocclusions was examined in detail by R.R. Turaev [114] using the example of certain districts of Kazan with an unfavorable environmental situation; it was revealed that in these districts of the city the frequency of such pathologies among children and adolescents was 57.9 %.

Analogous studies were conducted in the Republic of Bashkiria in areas with poor environmental situation – malocclusions were found in significant quantities in Ufa (71.37%), Neftekamsk (67.94%), Beloretsk (68.1%) [24]. The author established absolute and relative risk factors that determine the onset of malocclusion in children. However, the work did not conduct a clear comparative study in areas with neutral or favorable conditions, which would have increased the significance of influence of said environmental factors.

When discussing the influence of environmental factors on the development of DFA, one noteworthy factor is the fluoride concentration in drinking water and food

products. A study of children and adolescents in Karaganda (Kazakhstan) revealed a correlation between the spread of caries, fluorosis and malocclusion [6, 7, 8]. The prevalence of anomalies among preschoolers was 29.8% and 47.4% among schoolchildren. Fluorosis in destructive, severe forms led to pathological abrasion of enamel and destruction of dentin. Abrasion directly affected changes in bite height, which also had a detrimental effect on the functioning of the TMJ and facial muscles. It should be noted that the structure of anomalies in this selection was dominated by complicated forms of pathologies. These studies clearly show the relationship between caries with its complicated forms and the occurrence of malocclusions. Complicated, advanced forms of caries in primary and permanent teeth lead to early tooth loss and, as a result, in the absence of adequate prevention and treatment, to the occurrence of certain malocclusions.

While writing current work, various studies regarding physiological posture and its relationship with a particular malocclusion were also studied. Among them is the work of Heike Korbmacher (Germany) [235], which describes the process of changing the position of the cervical vertebrae in individuals with the second skeletal class of occlusion. The author also conducted research on the relationship between scoliosis and lateral crossbite. Postural problems could partly be a trigger for the start of the development of occlusion anomalies, especially if patients lack compensatory factors and have bad habits: a sedentary, inactive lifestyle, the habit of slouching while sitting at a table, and others.

Studies of posture and its correlation with bite were also carried out on animals (Festa F., Datilio M., Vecchiet F.) – the authors conducted series of research on mice in vivo and proved that changes in the height of the bite and the position of the lower jaw lead to changes in the position of the cervical vertebrae are a trigger for a number of motor and neural changes in the neck [181].

However, one should avoid drawing a direct connection between postural anomalies and all occlusion pathologies; a number of works show the lack of a confirmed evidence on this issue [224], describing a number of factors in which this relationship will have a clinical justification [193, 266], and mentioning complex

interrelation of these problems, in which they are equally likely to either influence and aggravate each other, or have absolutely no effect [151].

As a result of the analytical data collection on the issue of the influence of posture on the occurrence and development of malocclusions, the following conclusion was drawn: the relationship between these two processes can undoubtedly be traced, but the issue lies deeper than just “DFA = presence of posture pathology”. This is evidenced by both the data presented in the above-mentioned works and the latest research and achievements in the field of functional dentistry.

According to the literature analysis, functional disorders associated with improper function of the lingual muscle affect a limited number of anomalies and require a more in-depth and detailed study. However, it is worth noting that several researchers closely associate malocclusion with improper tongue function also with a weakening of the orbicularis oris muscle and surrounding soft tissues. The lingual muscle, like the rest of the musculature of the maxillofacial region, is closely connected with the alveolar process of the jaws both anatomically and embryologically, therefore the connection between DFA and tongue dysfunction is undeniable.

Furthermore, several researchers point out the relationship between certain malocclusions and the lingual muscle functionality. The research by P.Chakraborty and P.Chandra regarding the tone and size of the lingual muscle is one such work. The authors found that with an increase in the size of the tongue, the group of patients they examined had impaired swallowing, which in turn led to biprotrusion of the incisors and, in some cases, to the occurrence of an open bite [163]. This study is confirmed by the works of other scientists and practitioners, including the works of Graber (1975), who closely linked the shape and size of the jaw arch with the size and shape of the tongue [185, 186]. These studies echo the work of Naosuke Doto (2015), in which the author suggested the existence of a relationship between the influence of the tongue and dysfunction of the orbicularis oris muscle [173].

Another important mention is the connection between the presence of bad habits and the development of DFA. Carvalho (Belgium) et al (1998) [162] draw attention to

the high incidence of malocclusion pathologies at the age of 3-5 years in children with persistent bad habits (pacifiers, fingers in the mouth).

Nutritional factors also play an important role in the development of DFA. For example, John Mew (Britain) [221] pointed out the importance of a harmonious and proper diet for a child, in which hard foods would predominate, which promotes both timely teething and the development of jaw bones and muscles. A balanced diet, rich in solid foods, has a beneficial effect on the development and condition of periodontal tissues, and is also a trigger for timely and harmonious change of teeth. Begg and Kessling (1977) (Australia) suggested that low levels of unprocessed foods in the diet lead to crowding of individual teeth or groups of teeth, reinforcing said concept. The authors conducted a study on the abrasion of chewing surfaces in the aboriginal population, whose diet was dominated by hard foods [156].

The nutrition style is an important factor in the formation of malocclusions, but it affects the nature of their formation indirectly. Rix (1946) found that part of the group of people with DFA he examined tended to insert the tongue between the frontal teeth when swallowing [252]. Among such individuals, the muscles of the orbicularis oris and cheeks are well-developed, which creates the necessary negative pressure for ingesting liquid food. According to many researchers and authors [144, 158, 167, 177, 205, 206, 225, 230, 261], this phenomenon is associated with an incorrect transition from breastfeeding to artificial feeding of children. Levine (1998) found that the habit of sucking fingers, pencils and pacifiers is characteristic of Western civilization and is practically absent among primitive peoples, among whom breastfeeding is sometimes practiced until 3-4 years of age [209]. Gil Rapley conducted a series of studies [248, 247], concluding that breastfeeding can be discontinued after 9 months, after the child learns to swallow solid foods.

Based on all the data above, the following conclusions were be drawn:

1) the nature of the child’s nutrition is important, coupled with the eating habits acquired when changing from breastfeeding to artificial feeding;

2) an abundance of liquid food, pureed and processed food leads to disruption of the functioning of the muscular complex of the maxillofacial area, which contributes to the formation of occlusion anomalies.

The influence of insolation and vitamin D deficiency on the appearance and development of malocclusions is worth a separate mention. Chhonkar et al. [164, 165] revealed a direct effect of vitamin D active substances on the dental status of children during an examination of Indian children and adolescents.

According to the research they conducted, children with a high prevalence of caries had a pronounced deficiency of vitamin D. Another important property of vitamin D is its role in the development and normalization of the functioning of muscles, including the maxillofacial area. Foreign scientists have conducted numerous studies [190, 207, 222] on the effect of vitamin D on the muscular system. Authors described the presence of VDR muscle receptors, which allow vitamin D to be absorbed directly by the muscles and play an important role in the absorption of calcium and phosphorus by the body.

The influence of nutritional factors cannot be denied; however, when compiling and analyzing various research, both from domestic and foreign sources, we discovered that the frequency of malocclusion remains extremely high regardless of the region of residence of the respondents, which leads us to the conclusion that the influence of the insolation factor on the risk and course of DFA is extremely low. However, the nutritional theory, the impoverishment of children's diet, and soft and vitamin-poor food could have a certain impact on the development of malocclusions.

Noteworthy is the self-regulation of processes associated with dental anomalies in children and adolescents. In this context, we can mention the study by Pirttiniemi et al. (2016) [242], which analyzed data from 1966 adults in Northern Finland and identified 39.5% of cases of DFA among respondents (crossbite – 17.9%, deep bite – 11.7%, distal bite – 9.7 %). This study clearly shows that, despite the growing age of the group at risk for DFA (children and adolescents), the frequency of pathology remains at a high level. This indicates that malocclusions are often not compensated mere by the growth

of the jaw bones; certain etiological factors do not go away with age but are often complicated and aggravated.

As mass examinations of schoolchildren reveal, equipment treatment is required in 45% of cases, various preventive measures – in 11.8%, early prosthetic intervention – in 1.9% [104, 34]. Based on the data obtained by the author, the high need for hardware treatment is relevant during the period of mixed dentition, which can be explained by certain physiological and pathophysiological reasons.

Therefore, after analyzing the domestic research literature covering the problem of the prevalence of occlusion anomalies, we concluded that the highest frequency of malocclusions occurs in temporary and mixed dentition. Such phenomena occur due to numerous reasons:

- firstly, at early school age, the processes of bone tissue growth are active, bone sutures are still quite elastic and pliable to loads, and under the influence of pathological factors, phenomena can occur that lead to the occurrence of occlusion anomalies – hyperfunctioning of muscles, uncontrolled bad habits, etc.;

- secondly, in this age group the process of physiological change of teeth begins, the disruption of which also leads to the appearance of DFA.

H.A. Kalamkarov et al. noted an increase in the frequency of DFA in the initial period of mixed dentition (7–10 years) during examinations of children [93]. This may suggest both physiological reasons for the deterioration of the picture with the prevalence of malocclusions (skeletal type of anomaly, growth of bones of the maxillofacial area), morphofunctional (problems with nasal breathing, hyperfunction of the tongue), and the influence of harmful factors.

Y. M. Malygin and H.A. Korolkova (1978) found that DFA in the period of primary dentition occurs in 24.0% of children, in the mixed dentition – in 49.0 % in their in-depth analysis of 1200 author's domestic monographs, comparative studies, scientific articles and other sources of domestic literature, [64].

Research carried out by D.S. Kozlov had also shown the frequency of malocclusion in early mixed and permanent dentition: the variability of occlusion among children 7, 12 and 15 years old is 74%, 82% and 72%, respectively [51]. This

data indicates an increase in the number of malocclusions during the formation of a permanent dentition, during the formation of which the growth of the jaw bones also starts.

Rublevsky D.V. et al. [97] examined 1096 children aged 7–10 years from Minsk and Mogilev. 136 children undergoing orthodontic treatment at the time of the study were excluded from the final group. According to the researchers' findings, the prevalence of crowding of the lower jaw teeth in children during the period of mixed dentition was 41.97%, and isolated from other anomalies of the maxillary jaw – 28.53%. Moreover, in 19.85% of cases, based on the data presented by the author, the pathology had the potential for self-regulation due to the growth of the jaw bones and the activity of the tongue. At the same time, the author found that mesial occlusion is less common in children with a crowded position than deep bite and occlusion anomalies associated with narrowing of the upper dentition, which can be explained by the active growth of the bones of the lower jaw.

According to Korkhova N.V., Sakadynets A.O., Korneeva A.S. [54], the prevalence of pathology of the dental system in the child population of Minsk and the Minsk region (Republic of Belarus) is 81.2%, with a neutral bite in combination with anomalies of the dentition and individual teeth was detected in 44.3% of the examined children. It should be noted that the authors noted a steady trend towards an increase in dentoalveolar anomalies in the age period of 7–9 years, as well as a decrease in bite anomalies during the period of late mixed dentition at 10–12 years, which, no doubt, is associated with the processes of self-regulation of pathology due to active growth and development of the dental system. It should be noted that, according to said study, anomalies of individual teeth are not always directly associated with anomalies of occlusion and could occur even with a neutral jaw relationship.

A comprehensive analysis of the scientific research literature made it possible to note that, despite the huge layer of statistical and analytical data on the etiopathogenesis of DFA, the results of studying the empirical data of various authors are contradictory and often provide an incomplete picture of the theory of the occurrence of malocclusions. The relationship between various etiological factors on the development

of DFA has been poorly studied, and the genetic causes of occlusion anomalies are not sufficiently covered. It seems obvious that odontogenic factors influence the pathogenetic picture of the development of malocclusions.

In this regard, it is worth noting certain triggers that, to varying degrees, could in one way or another affect either the development of DFA or aggravate the course of an existing process. These factors are so different from each other that it is not possible to include them in one or another classification approach.

First factor is the dysfunction of nasal breathing. In childhood and adolescence, this is associated with chronic inflammatory processes occurring in the nasopharynx, hypertrophy of the nasal mucosa and paranasal sinuses, which leads to compensatory oral breathing. This predisposing factor was placed in first place due to the widespread occurrence of respiratory diseases. As we see from the analysis of literary sources, the lack of proper attention to the physiological act of breathing leads to a number of morphofunctional changes in the maxillofacial area.

The second factor is the violation of posture. This factor is important for the selected age group due to the following points: postural pathologies occupy the second ranking place among schoolchildren's morbidity after respiratory diseases, often in most cases they are acquired. However, as the analysis of scientific literature shows, occlusion pathology is not always directly related to poor posture. In order for a violation of posture to affect a change in the activity of certain muscle groups of the maxillofacial region, a number of conditions must occur. The works reviewed in the literature review often indicate an unexpressed relationship between the development of malocclusions and problems with posture in children and adolescents.

Another determining factor in the etiopathogenesis of occlusion anomalies is early tooth loss due to advanced forms of caries. Caries is one of the most common diseases in the world; in the child population its prevalence reaches 90–95%. The literature review led to the conclusion that children with malocclusions are more likely to suffer from dental caries and the effectiveness of preventive measures is lower than the average among children [111]. It is worth noting that individuals with caries-resistant teeth have more developed and correctly formed jaw bones, a predominant

tendency towards a horizontal facial type, while individuals with multiple caries often have a less developed facial structure, a predominant tendency towards vertical growth [61]. V.A. Distel [36, 37] points out that there is no significant difference in the development of the jaw bones of caries-resistant and caries-prone children in the primary dentition; the author noted the appearance of differences during the formation of the mixed dentition, primarily in the width of the alveolar processes. The intensification of reductive processes in the alveolar processes leads to the appearance of anomalies associated with a lack of space in bone tissue – crowding and dystopia of individual teeth, which, due to the anatomical features of their location, leads to the appearance of multiple foci of carious lesions. Based on this, the following conclusions can be drawn:

1) tooth reduction is an adaptive mechanism with reduced sizes of alveolar processes;

2) adentia of certain teeth or groups of teeth is a reduction of the masticatory apparatus and is the same adaptive mechanism in the case of a destructive carious process.

Numerous scientific monographs directly indicate a correlation between the frequency of malocclusions and tooth loss as an outcome of caries complications; the risk of developing DFA is also high during the period of mixed dentition. This confirms the hypothesis of L.S. Persina (2004) [80, 81, 82, 83] about the early loss of the rudiments of temporary and permanent teeth and the early removal of permanent erupted teeth, according to which in the case of untimely tooth loss, morphological changes occur in the alveolar process of the child, and the growth of the jawbone area is disrupted.

All this emphasizes the importance of carrying out preventive measures for the purpose of early detection of malocclusions and predisposition to them among children and adolescents.

1.3. Relationship between malocclusion and socio-economic factors

As noted earlier, the frequency and severity of malocclusion is determined by numerous etiological factors. Therefore, during the initial examination of a child, prenatal and birth anamnesis, anamnesis of hereditary diseases of the parents, and the presence of endocrinological pathologies in relatives are also important.

However, we should not disregard the socio-economic status of the family, which determines the somatic and psychological well-being of the child [188]. This status is determined by the following criteria:

- level of education of parents,
- profession and income level of parents,
- social status, etc.

Unfortunately, the relationship between anomalies of dental development and socio-economic factors has not been thoroughly studied in Russian Federation, and the conclusions of existing domestic studies contradict foreign analogues.

According to Anistratova S.I., socio-economic differences and inequality in society could lead to a lackluster potential for self-realization, receiving an education, and influencing the formation of lifestyle and health of a child [11]. The above indicates the necessity of all the beneficial factors, in particular dental ones, in maintaining the health and harmonious development of a child.

Some authors emphasize the influence of the “female factor” in shaping care for the health of teeth and gums. Derevyanchenko S.P. [35] revealed that this habit is mainly passed down and taught by female parents. It is also worth noting that mother’s attitude towards both health and hygiene of the oral cavity plays an important role in the development of caries, gum disease in children, and the formation of habits related to dental health [198].

Certain Western researchers have proven the direct and indirect influence of socio-economic factors in the development of a child’s dental health. Jacobsson B. et al., during examinations of children and adolescents of various social and ethnic origins, discovered that the level of intensity of caries and gum pathologies directly depends on

the level of social well-being of the family, area and place of residence, and social status [199].

Oral health is also influenced by patients' motivation and desire to improve it, with the patient's own efforts being the most important. However, it is worth noting that such motivation increases with a high level of education and social status [14].

In a study conducted in Brazil and devoted to identifying the need for dental treatment among schoolchildren 8–10 years old, it was revealed that the motivation was significantly higher in families with low social status. The presence and quantity of caries was lower in children from families living in prosperous areas and where both parents had a college degree [257].

The need for tooth extraction and total prosthodontics is higher in families with low parental education [130]. As Mejia G. suggested in an analysis of data from Australia's National Survey of Adult Oral Health 2004–2006 (Australia), in the case of social inequality in adults, the risk of tooth extraction in children increases [220].

The topic of the correlation between socio-economic factors of the family and the dental health of children is of interest to domestic scientists, but it has not yet received due attention and research. In the work of researcher N.V. Kuyumjidi [59] did not find a significant effect of the parental education level, their profession and whether there are two parents present, on the prevalence and severity of caries in young children. This somewhat limited attention which was paid to the work of researcher E.V. Romanchuk [94], who, on the contrary, discovered a clear inverse correlation between the level of education of parents and the incidence of caries in children. However, the strength of the correlation for these factors, according to the author, remains insufficiently studied.

In this regard, it is worth noting that the lack of research in this area may be due to various factors. It is possible that parents' lack of awareness about proper oral and dental care plays a role in the formation of dental problems in their children. It is also possible that economic constraints may influence the availability of quality dental care and preventive care for children from low-income families.

To further study this topic, it is necessary to conduct comprehensive studies that consider not only socio-economic factors, but also lifestyle, nutrition, oral hygiene and other influencing factors. It is also important to mind the age characteristics of children since dental problems can develop differently at different periods of life.

More in-depth and consistent research on this topic would allow to develop effective strategies for the prevention of dental diseases in children, especially in vulnerable socio-economic groups. This could in turn help improve children's dental health and improve their overall quality of life.

Furthermore, the psychological climate in the family and the presence of conflict situations in it, which negatively affect the dental health of all family members, are also important [48].

Researcher A.A. Sidaliev conducted a study [100] examining the relationship between socioeconomic factors and the prevalence of dental caries among schoolchildren in the city of Lipetsk. He noted that children with good oral hygiene and low dental damage were usually born into families where parents had higher education. The correlation coefficient obtained from the study ranged from -0.62 to -0.74, which confirms the inverse relationship between parental education and the prevalence of dental caries in children. An inverse correlation was also found between family income and the intensity of caries, where the correlation coefficient ranged from -0.32 to -0.74. This means that as family income increases, the incidence of dental caries in children decreases. But the strongest correlation was found between the presence of caries and the level of physical health, where the correlation coefficient ranged from 0.47 to 0.89. This suggests that the worse the physical health, the higher the likelihood of developing caries. A strong relationship was also found between the intensity of caries and the level of oral hygiene, where the correlation coefficient ranged from 0.72 to 0.97. This confirms that the lower level of oral hygiene is linked to the higher intensity of caries.

Therefore, said study showed that socioeconomic factors, such as parental education and family income, as well as physical health and oral hygiene, have a significant impact on the prevalence and intensity of dental caries in schoolchildren.

These results can be used to develop effective programs for the prevention and treatment of caries in children.

It should be emphasized that most bad habits that negatively affect the formation of the child's maxillofacial area are acquired as a result of improper upbringing of the child in the family. Such bad habits are rightly perceived by researchers as one of the extremely negative factors in a child's lifestyle and living conditions, which undoubtedly have a social nature [12, 15, 18, 90, 21, 27]. with different socio-economic status, as well as what activities are in this direction. For example, Ayupova F.S. conducted a retrospective analysis of medical records of children and adolescents who underwent orthodontic treatment in one of the medical institutions of the Krasnodar region [264]. As a result of the analysis, the author indicated that in most clinical cases, parents paid attention exclusively to pathologies associated with the anterior group of teeth in children, with the aesthetics of a smile and, accordingly, with the further social adaptation of the child. In another work, the author described in detail the most common causes of malocclusion, including in the frontal region, a large proportion of which were the child's bad habits – mouth breathing (23.8%), incorrect body position during sleep and wakefulness (11, 6%), impaired functioning of the lingual muscle (13.8%).

The development of the dental system is a complex process that depends on many factors. One important aspect is the myodynamic balance between synergistic and antagonistic muscles [112, 5, 98]. However, certain bad habits could disturb said balance and lead to abnormalities in the development of the dental system. In current work we would discuss causes of such anomalies and possible ways of prevention.

There are several bad habits that could negatively affect the development of the dental system. One is the habit of sucking, whether of fingers, lips, cheeks, objects or tongue. This action could lead to abnormal positioning of the mandible and tongue, which in turn disrupts myodynamic balance. Also, disorders of certain functions, such as chewing, swallowing, nasal breathing, speech or articulation, could negative affect the development of the dental system. In turn, incorrect position of the body at rest, incorrect posture and poor posture can also contribute to the occurrence of abnormalities.

Another common bad habit is biting nails, toys, objects or seeds. Constant stress on the teeth and jaws might cause an imbalance in myodynamics and negatively affect the development of the dental system.

Prophylaxis and fixing of bad habits play an important role in the prevention of dental anomalies. However, this process could be complex since each habit has its own nature and form of manifestation. For example, one of the ways to prevent the habit of sucking is to gradually wean the child from this action. This might require patience and constant reminders, but over time the child would be able to overcome said habit. When it comes to biting your nails or other objects, it is important to create alternative ways of relaxation or keeping one's hands busy, such as anti-stress toys or hobbies that require active use of your hands. Bad habits could seriously affect the development of the dental system. Therefore, an important element in the prevention and elimination of malocclusions is the prevention and elimination of these skills. Although they occur unconsciously and are inherently automatic, various methods are available to prevent and correct them.

Consultation with specialists could help develop an individual correction program and ensure the correct development of the dental system in children [50, 77, 82, 83]. Therefore, it is necessary for parents to control children, starting from the timely removal of pacifiers as an intermediate link between breastfeeding and independent feeding, up to the correction of habits associated with residual reflexes from natural breastfeeding – sucking fingers, toys, pencils and other things.

Thus, the analysis of research literature led to us discovering a direct relationship between various social, social and economic factors and the state of dental health. This emphasizes the importance of preventive methods and health education work among adults and children to strengthen both the dental and general somatic health of the child population. The discovered relationship between the socio-financial well-being of the family and the development of dental diseases, coupled with the development of bad habits in children, is obvious. This problem is not sufficiently covered in the author's works, which encourages further search in this direction. This topic is interesting from

the point of view of both the development of dental pathology itself and the influence of psychological and social factors on its development.

1.4. Modern methods of malocclusion treatment and prophylaxis

The arsenal of treatment tools and methods currently available to clinicians allows to solve any practical problem. However, the practitioner needs to have a certain knowledge of each treatment modality to achieve the most effective clinical practice [141].

Professor V.N. Trezubov formulated the feasibility of treating DFA in the temporary dentition, based on the principles of early treatment and prevention [113]. The problem of preventing occlusion anomalies in dentistry is one of the most significant and, according to most researchers, relevant. This fact is explained by the following:

- a low level of sanitary and hygienic knowledge and skills among parents and children;

- a low degree of patient adherence to the recommendations of the attending physician;

- patients often lack motivation to participate in preventive work [59];

- insufficient activity of pediatric dentists in addressing the issue of preventing DFA.

All the above-mentioned reasons explain the increase in the prevalence and intensity of DFA in children [90, 57, 39, 101, 102]. Since malocclusions occupy a significant component in the mass assessment of children's dental health, preventive treatment methods aimed at strengthening and improving dental and somatic health should become an integral part of the clinical treatment of children with temporary and mixed dentition [131].

Having thoroughly studied the etiology and factors of occurrence of occlusion anomalies, we can come to the logical conclusion that the prevention of occlusion

anomalies should begin from the moment of pregnancy planning and involve not only dentists, but also general practitioners in these activities [72].

Among domestic researchers, a complete guide to preventive measures for a pregnant woman and child was developed by F.Y. Khoroshilkina [120, 121]. Said guide covers both the intrauterine development of the child, periods of lactation and mixed dentition, and preventive actions for occlusion anomalies associated with the loss of permanent teeth in adulthood and old age.

Various instrumental and combined techniques are traditionally used to treat and prevent anomalies. Any orthodontic treatment is staged and includes active and retention periods. The result of the active phase of treatment is the achievement of a functional, morphological and aesthetic optimum; the retention period is the creation of conditions for the functioning of the resulting occlusion, the achievement of myodynamic balance.

Y. L. Obraztsov [75] emphasizes the importance of early treatment and prevention of DFA at the age of 3–6 years. On the other hand, clinical data from Patti (2005) [239] suggest that orthodontic treatment is not recommended to begin before the eruption of the second molars and the entire group of premolars. However, if we analyze the fundamental work of T. Graber (USA) (2000) [185, 186] and accept the theory of the stability of the results of orthodontic treatment, according to which early treatment has certain advantages for long-term stable results, it could be argued that orthodontic treatment should be carried out at the earliest possible age of the child.

It is worth specifying the goal of early orthodontic treatment, which is the prevention or minimization of skeletal, muscular, and dentoalveolar disorders in the dental joint, namely:

- elimination of skeletal imbalances;
- improvement of occlusion;
- harmonization of facial aesthetics;
- elimination of bad habits;
- simplification of further orthodontic treatment.

The choice of orthodontic removable device depends on the nature of the malocclusion. Mechanical devices are used to expand the jaws, protracting individual teeth or segments. The mechanism of action is to create a support in the form of locks (Angle apparatus), crowns or rings (Mershon apparatus, Ainsworth apparatus), a base with clasps (Coffin plate) and an active element: an arc, a spring, which must be activated from time to time. Functional devices affect the anomaly in the posterior joint only during function (movement of the tongue, movement of the oral muscle, etc.). In this case, a work phase and a rest phase are distinguished, during which the device does not disrupt the blood supply to the periodontium and balances the processes of apposition and resorption of bone tissue [250].

At primary school age (6–7 to 9–10 years), the main attention is paid to prophylactic methods of preventing DFA. As a result of the literature analysis on this issue [263, 225], two main methods of prevention applicable in clinical practice can be identified:

- a preclinical method, which begins with pregnancy planning, exclusion of genetic factors influencing the formation of DFA, competent management of pregnancy and monitoring of fetal development, exclusion of birth injuries of the maxillofacial area, timely surgical treatment of maxillofacial anomalies: cleft lip, nonunion of the palate, etc., training parents the basics of dental literacy, the correct structure of the child’s diet, monitoring the condition of erupted teeth, eliminating bad habits (sucking pacifiers, fingers, etc.), monitoring the change in bite.

- a clinical method that includes the prevention of emerging malocclusions due to early tooth loss, injuries to the maxillofacial area, bad habits (hardware treatment, etc.).

During the primary and early mixed dentition, preformed trainers and activators have proven to be a good preventive measure [195], the wearing of which could be combined with speech therapy correction. The John Mew bioblock should also be consideren an effective preventive device [221], which is most productive during the same period (3 to 10 years of age). The device is effective not only in terms of correcting malocclusion, but also in correcting the factors leading to its appearance or aggravation. It helps to correct the position of the tongue and the tonus of the orbicularis

oris muscle. Also, one should not disregard the existence of various special preventive orthodontic devices, designed for both correction of various bad habits and normalization pf nasal breathing function.

When discussing the treatment in adolescence and adulthood, it is worth keeping in mind that special treatment is usually long-term, associated with repeating relapses and complications, and many patients do not complete the treatment they have started [56, 79, 103].

Those problems are mostly caused by an increase in bone tissue density compared to its childhood state, an active decrease in its plasticity, as well as a slowdown in metabolic processes [103].

The recurrence of DFA, as explained by certain authors [50, 67], occurs due to several reasons:

- insufficient time spent on prosthodontics treatment, followed by inadequate reorganization of gingival and periodontal tissues;

- constant pressure of the soft tissues in the maxillofacial area, especially the lingual, buccal muscles and orbicularis oris muscles;

- changes associated with the physiological growth of the patient, namely the jaw bones.

The defining success factor of orthodontic treatment is its duration, which directly affects the patient's motivation for treatment, as well as side effects caused by the hard and soft tissues of the teeth [168]. The main factor determining this aspect is the morphological features of the patient's bone tissue structure. In this regard, the issue of stimulation and intensification of metabolic processes in periodontal tissues is important. Several studies suggest the use of medication [58] and physiotherapeutic support during orthodontic intervention to reduce the number of complications of purulent-inflammatory origin, accelerate bone tissue recovery and, as a result, reduce the duration of treatment.

For example, in laboratory experiments on Wistar rats, ascorbic acid was used to retain the palatal suture, which had a positive effect during the first week of the experiment, but by the ninth day it had a negative effect on osteogenesis [179].

It is interesting to study the effect of osteoprotegerin on bone tissue synthesis in this context [212]. During clinical experiments, the authors found a significant reduction in relapses associated with impaired osteogenesis, an increase in mineral density and bone volume. A comparative morphological assessment of the effectiveness of the use of perftoran in a complex of lymphotropic antibacterial therapy on the regenerative capabilities of the bone tissue of the lower jaw in an experiment on white rats gave a positive effect on the development of bone regenerate in the area of the defect [63].

It is also worth to mention the experience of using physiotherapeutic means and techniques at all stages of orthodontic therapy. The combined use of calcium chloride electrophoresis in combination with vibration massage showed a positive effect in the retention period of treatment [91]. The use of ultraphonophoresis of 10% calcium chloride in combination with a dosed vacuum has proven itself to be effective. Patients experienced a significant reduction in the duration of orthodontic treatment during experiments with this technique, especially in the retention period [34].

Speaking about side effects during orthodontic correction, we should mention focal demineralization of the enamel during treatment. Fixation of long-term orthodontic equipment entails not only a quantitative, but also a qualitative change in the microflora of the oral cavity. Due to the sharp increase in microbial mass, the activity of pathogenic microflora, including conditionally pathogenic ones, increases. The main foci of accumulation of microbial plaque are the bases of braces and the cervical region – immune zones for caries genesis [128]. Thus, orthodontic treatment is an intervention in the natural balance of the microflora of the oral cavity, and with an ineffective and inadequate level of oral hygiene, it will ultimately lead to generalized demineralization of hard dental tissues [29].

Resorption of the apexes of tooth roots is primarily associated with increased load on the periodontium during orthodontic correction; to varying degrees, loss of hard tissue of tooth roots occurs everywhere during orthodontic correction [107]. It is worth noting that the process of root destruction stops upon completion of treatment, the process of periodontal restoration begins, cement is formed again in the lateral sections

of the roots, but in the apical sections the process of its loss is irreversible [103, 136, 172].

Orthodontic treatment could also trigger an exacerbation of chronic oral diseases: periodontitis and gingivitis. The first one is closely related to the movement of tooth roots, increased load on them and an increase in the specific gravity of the oral microflora [250]. The second is explained by mechanical irritation of the gum edge, especially in patients with low clinical crowns. Typically, adequate hygiene and timely visits to the dental hygienist are sufficient forms of prevention [108].

Despite the large number of original works and monographs [161, 234, 244], regarding the use of various biomechanical methods of orthodontic correction, questions remain unanswered regarding the consistency, rationality and timing of their use in orthodontic practice. Prophylaxis of DFA is an important component of children's health. Due to the multifactorial nature of these diseases, effective prevention requires close collaboration between various specialists. The orthodontist plays a key role in the prevention of DFA. He should also cooperate closely with other specialists (both medical and pedagogical), such as a dental hygienist, a pediatric dentist, a pediatrician, a speech therapist and others [20, 26, 46, 47, 88].

A local pediatrician plays a special role in this process, as he has the opportunity to explain the importance of correctly choosing and using a pacifier, eliminating nasal breathing problems, monitoring teething and developing teething skills to parents. He also plays a key role in educational work with parents and staff of children's educational institutions, which helps to prevent the development of DFA.

Health education work with parents and teachers is an integral part of the prevention of DFA [101, 102]. Providing information about proper oral and dental care, healthy nutrition and compliance with hygiene standards helps prevent the development of diseases of the maxillofacial area.

Correct and timely identification of symptoms and risk factors for the development of DFA is a crucial aspect of prevention. Early diagnosis allows to prevent the development of the disease and avoid expensive orthodontic treatment. Experts

recommend the active involvement of teachers and parents in this process, which contributes to more effective prophylaxis.

Prevention of diseases of the maxillofacial region in children requires the joint efforts of various specialists. Orthodontists, dental hygienists, pediatric dentists, pediatricians, speech therapists, and other experts must work together to prevent the occurrence and progression of DFA. Prevention programs based on health and hygiene education, early diagnosis and risk elimination are relevant and effective in combating these diseases.

1.5. Modern aspects of the malocclusion's prophylaxis

Dental health is an important part of one's overall health. Therefore, special attention should be paid to preventive measures aimed at maintaining it and timely discovering certain pathologies.

The problem of dental prevention is important and relevant, especially in childhood and adolescence, and is propagated by certain factors:

- low level of sanitary and hygienic knowledge among parents and children;
- low motivation to participate in preventive measures;
- insufficient involvement of dental specialists in the process.

All these problems determine the high prevalence of dental diseases in children.

Researchers subdivide the malocclusion prophylaxis into primary, secondary and tertiary, depending on the time of its onset in relation to the manifestation of existing orthodontic disorders. Preventive measures are also divided into different levels of implementation: mass, group and individual.

Primary prophylactic measures are carried out in children during the period of eruption of primary teeth and change of bite – i.e. in infancy, early and preschool age. The range of specialists involved in preventive measures at this stage is quite wide: dentists of various profiles, pediatricians, staff of preschool institutions; at a certain stage, teachers and school medical workers can be included in preventive work.

The following stages are included in primary prevention: mass-oriented sanitary and educational work; medical examination of children of various age groups, carried

out both directly in kindergartens, schools and boarding schools, and in children's dental appointments in state dental clinics; corrective orthodontic treatment, which consists of the doctor making individual removable appliances of different mechanisms of action. At this stage, children of the first and second groups of dispensary observation are monitored.

Secondary prophylaxis includes direct orthodontic or combined methods of treating the DFA itself and the aesthetic and functional disorders associated with it. Secondary preventive measures apply to children of the third and fourth dispensary groups.

Tertiary prophylaxis consists of preventing relapses of previously treated malocclusion and maintaining achieved treatment results. For this purpose, the orthodontist uses various methods: a non-removable lingual retainer, removable splinting equipment.

Clear comprehensive preventive measures have a beneficial effect on both dental and somatic health in general, lead to the harmonious growth and development of the facial skeleton and jaw bones, normalize the process of teething, improve the aesthetics of the maxillofacial area, thereby preventing the emergence of social and psychological complications, has a beneficial effect on the development of articulation and speech in general.

Dental prevention is not new and has been a hot topic for a long time. At an expert meeting of the WHO, which was held in Moscow in 1977, the following definition of ‘dental prevention’ was developed as ‘a system of social, medical, hygienic and educational measures aimed at ensuring a high level of health and preventing the occurrence of diseases by eliminating the causes and conditions their occurrence’ [92].

In preventive dentistry, scheduled measures are carried out through the sequential solution of certain tasks [123]:

1) assessment of the epidemiological situation at various levels, considering the indicators of dental and somatic health of the population under study, after which the

identification and assessment of factors affecting the occurrence and development of dental diseases is realized;

2) organization and implementation of preventive measures at various levels. Finally, an analysis of the effectiveness of the measures taken for subsequent correction of the prevention system is carried out.

Based on the observations of many authors, the prevention of DFA is most effective during temporary and mixed dentition periods. The effectiveness of prevention is significantly reduced in later periods due to a number of physiological factors.

Many specialists consider anomalies to be a connecting link between the etiopathogenesis of periodontal diseases and hard dental tissues, however, this claim requires further studies.

As mentioned above, malocclusion is a multifactorial pathological process; accordingly, the prophylaxis should be carried out in association between dental specialists, pediatricians and non-medical experts in the field of child health: speech therapists, etc.

This perspective highlights the importance of a local pediatrician in preventive measures. In his daily practice, he monitors the proper development, growth and health of the child, and explains to parents the importance of choosing and monitoring the use of pacifiers, timely treatment of respiratory diseases, monitoring the teething of the child, teaching how to care for them, and proper feeding and planning the child’s diet.

Sanitary and hygienic education is an effective and low-cost event from an economic point of view, which also does not require the allocation of separate labor resources.

It is worth noting that the timeliness of preventive and diagnostic measures often allows to begin timely treatment of DFA at the early stages of the formation of malocclusion pathology, which in turns leads to lesser financial costs.

Preventive measures aimed at changing the prevalence of malocclusions are however hindered by the following factors:

- multifactorial etiology of the occurrence of occlusion anomalies;

- the ability to influence the development of malocclusions within a certain age range.

As mentioned earlier, DFA has many etiological factors that can lead to the appearance of different pathologic forms. Based on this, the implementation of a prophylaxis program should include not only the involvement of dental specialists, but also general practitioners – pediatricians, otolaryngologists, chiropractors, osteopaths and others.

After analyzing the literature, we found that therapeutic measures in orthodontic practice regarding skeletal anomalies are tied to growth spurts in children; accordingly, the most fruitful treatment and prevention are possible during this period. This, however, does not apply to dentoalveolar anomalies, the treatment and prevention of which we can carry out in any age group of children [124, 127].

In conclusion, the development of a comprehensive program for the prevention of occlusion anomalies, which requires the involvement of both dentists, pediatricians, and teachers, educators and other specialists, is the cornerstone of modern practical orthodontics, especially in the age of high malocclusion prevalence in all age groups of the population.

CHAPTER 2. MATERIALS AND METHODS

2.1. Study design and stages

The study was carried out in six stages:

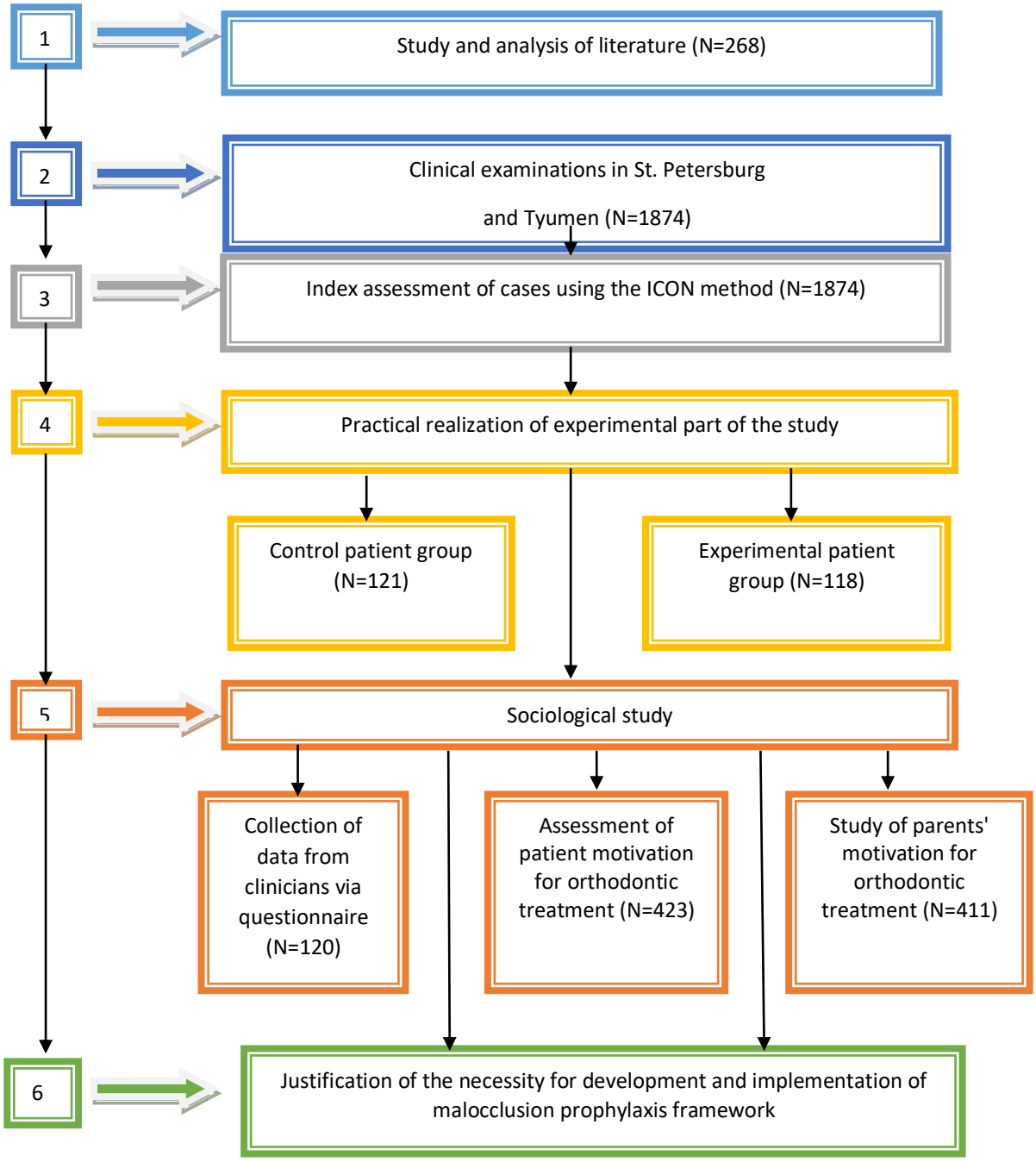


Fig. 1. Study design and stages

To achieve the objectives set in the introduction, a three-stage study was carried out during the 2017-2022 timeframe. The research was carried out among schoolchildren in the cities of St. Petersburg and Tyumen who underwent routine dental

examinations at the Regional Hospital No. 19 (GAUZ TO Regional Hospital 19) (Tyumen) and the City Children's Dental Clinic No. 6 (GBUZ GDSP No. 6) (Saint Petersburg).

The work was structured in accordance with the systematic approach methodology using basic principles of medical and statistical analysis. Primary documentation, plan and program of the study were approved by the Ethics Committee of the university.

As dictated by set goals, the object of study was the orthodontic status of children, which was determined based on age, gender and previous orthodontic treatment. The subjects of the study were 967 children and adolescents aged 6–14 years and their parents or legal representatives. All patients who took part in the study were urban residents. The choice of age groups was justified by following reasons:

1. Physiological change of teeth. At the age of 6–8 years, the process of the primary bite changing to a permanent one actively begins, while 12–14 years is the age at which a full-fledged physiological permanent bite is formed.

2. Various methods of treatment and prevention of DFA are used in this age group. Also, in these age groups certain anatomical and physiological features are present – the rate of bone tissue growth is quite stable, while the growth processes continue simultaneously, which allows the use of orthodontic equipment with various action mechanisms for a long time without fear of negatively affecting the growth process itself. It should be noted that at the age of 6–8 years, the physiological processes of restructuring of the respiratory organs are activated in a child – the diameter of the respiratory tract increases, the respiratory rate decreases, the role of the chest in respiratory movements is activated. In connection with these changes, it is necessary to monitor the child’s transition to proper nasal breathing. The choice of these age groups is due to changes in the digestive system in a 6–8-year-old child; it is no different from an adult. At the age of 12–14 years, children finally develop a permanent bite; certain occlusal anomalies become stable and pronounced. Treatment of most pathologies requires an integrated approach that considers both the DFA itself and its possible pathogenetic consequences. These age groups are also interesting from a psychological

point of view as 6-8 year old children have a more labile psyche, which makes it easier to learn prevention, improves motivation, and helps in eradicating existing bad habits. The child's behavior at this age contains a significant element of play, yet at this point child already starts to think analytically and adapts to the educational process. In adolescence, a complete personal and psychological restructuring of the child is observed – infantile behavior completely disappears, adolescent psychology begins to search for its own identity. At this age, children are often bullied because of problems with their appearance, including bite problems, which is why solving orthodontic problems in adolescents also plays an important psychological role.

Based on numerous studies, we concluded that the primary school age is the most advisable time to introduce a comprehensive preventive program. In addition, it is the school environment where children begin to visit dental offices, undergo routine examinations and medical examinations, which simplifies the process of implementing and monitoring the implementation of the program.

The City Children's Dental Clinic No. 6 of the city of St. Petersburg (hereinafter referred to as GDSP No. 6) and the City Autonomous Healthcare Institution of the Tyumen Region Regional Hospital No. 19 of the city of Tyumen (hereinafter referred to as GAUZ TO No. 19) were chosen as the clinical base.

St. Petersburg is a city of federal significance and is the second most populous city in Russia – as of January 1, 2020 – 5398.06 thousand people. The child population 6–14 years old is 4.77% (2020). St. Petersburg is a multimillion-city with a high and constantly growing share of the migrant population.

The main types of economic activity are wholesale and retail sale of goods and services, manufacturing and much more. The basis of industry in St. Petersburg is heavy industry, including power engineering. Ferrous and non-ferrous metallurgy, transport engineering, historically developed shipbuilding and ship repair are developed. Some enterprises are located within the city limits (Kirovsky plant, Leningrad metal plant). In close proximity to the city limits lies a nuclear power plant (Sosnovy Bor). The radiation situation in the city is within normal limits (0.10–0.15 μSv/h, with an average value from 0.05 to 0.75 μSv/h). The concentration of technogenic nucleotides in the soil

is also at a low level – 137Cs (with minor fluctuations of 0.73–0.79 kBq/m²), the same situation is with the quality of water in open reservoirs, the concentration of nucleotides in which is at the level observed before the accident at Chernobyl Nuclear Power Plant [49].

Like other cities with an over-million population, St. Petersburg has an unfavorable environmental situation: overcrowding, air pollution from exhaust gases, background noise – these and many other factors have an extremely negative impact on the health of St. Petersburg residents. According to Rosstat, St. Petersburg took third place in air pollution in 2013 (after Norilsk and Moscow), and, as of 2020, St. Petersburg and the surrounding areas of the Leningrad region account for 199.1 and 261.2 thousand tons of air pollutant emissions respectively.

The climate of St. Petersburg and the Leningrad region is moderate and transitional (between continental and maritime), has high humidity (̃78%) and frequent precipitations. The average annual number of sunshine hours is 1628.

There are 1,109 preschool educational institutions and 694 secondary educational institutions in the city and region [16]. There are 39 state budgetary healthcare institutions in the city, which include children's dental clinics, pediatric dentistry departments and pediatric dentists' offices.

GBUZ "City Children's Dental Clinic No. 6" is situated in the Admiralteysky district of St. Petersburg and provides dental help to the entire child population of the area. Admiralteysky district (according to Rosstat, 2018) has a children population of 43.5 thousand (aged 0 to 18 years). GBUZ GDSP No. 6 has a fully staffed medical team, modern equipment and material resources, thus providing complete and effective pediatric dental care [30].

The clinic has surgical dentistry, pediatric therapeutic dentistry, orthodontics and physiotherapy departments. There is an X-ray room and clinic’s own dental laboratory, where various removable and non-removable orthodontic devices are manufactured. There are also separate locker rooms for staff, a rest room, and a resident’s room.

GBUZ GDSP No. 6 working hours are 8:00-20:00, Monday to Saturday, and on Sunday it is open around the clock.

The city of Tyumen is the administrative center of the Tyumen region (hereinafter referred to as TO, short for Tyumen Oblast'), the largest city in this region with a population of 807.4 thousand people (as of December 2019). The share of the child population from 6 to 14 years old is 8.15%.

Tyumen belongs to the category of large cities (with a population between 250 thousand and 1 million people). Notably, a prominent demographic feature of the city is an ongoing population boom.

Tyumen is one of the main economic centers in the Russian Federation. The region's economy is based on oil and gas production, hydrocarbon processing, the south of the region is an important agricultural center, and there are chemical industry enterprises. The regional center and region are among the so-called "donor regions" of the Russian economy (according to the Ministry of Finance of the Russian Federation). There are no hazardous enterprises or industries in the urban agglomeration. The environmental situation in the city is monitored annually (Tyumen Hydrometeorology and Environmental Monitoring Center – a branch of the Federal State Budgetary Institution Ob-Irtysh UGMS). The environmental situation is generally favorable, exceeding the maximum permissible maximum one-time concentrations of pollutants was recorded only in 0.06% of cases (2019).

The climate is continental, precipitations occur mainly mostly in the autumn-summer period. The region is characterized by smooth changes in weather conditions. The average annual number of sunshine hours is 2066.

There are 56 preschool and 61 secondary education institutions in the city, the students of which are assigned to a number of city clinics (55 budgetary healthcare institutions, including 4 dental clinics, and dental departments are organized in a number of institutions). There is a program of the Department of Health of the Tyumen Region "Health Development" active in the region (project implementation period 2019–2025), the objectives of which include increasing the regional level of quality of medical care, providing a number of categories of citizens with specialized medical care, including dental care [31].

Regional Clinical Hospital No. 19 was chosen as the Tyumen base for our research for a number of reasons:

1. This medical institution has a dental department, staffed by doctors, dental technicians and equipped with an arsenal of modern diagnostic equipment.

2. Both children from Tyumen and the region undergo dental examinations at the Regional Clinical Hospital No. 19. The patients pool includes 31,355 children from 0 to 17 years, 11 months and 30 days of age [73]. Patient visiting hours are Monday to Friday 8:00 to 20:00, and 9:00 to 14:00 on Saturday and Sunday.

The hospital structure includes 6 outpatient clinics, 5 local hospitals, and 2 clinics, one of which is a dental clinic. There are six doctors employed currently. Dentistry department operates in two shifts. There are a therapy and a surgery room. The department provides services to children and adults. There are also a dental laboratory, an X-ray room, and a central medical center. There are a rest and meal room for the staff, a cloakroom for doctors and nursing staff (http://ob19.ru/).

Doctors carry out reception and dispensary registration of the children's population, which consists of planned sanitation of the oral cavity and planned prevention of oral diseases in schoolchildren and children from preschool institutions.

As part of the study, environmental conditions in the studied regions were also examined. As revealed, external factors play a certain role in shaping the preconditions for CSSD. Next, information will be presented on various unfavorable environmental factors in these regions.

The regions under consideration differ from each other climatically. St. Petersburg (Northwestern Federal District) belongs to the geographical zone around 60° N, which implies the most acute shortage of UV radiation. The south of the Tyumen region and Tyumen (Ural Federal District) are located somewhat further south – 57° N. A difference of a few degrees has a dramatic effect on insolation levels.

Table 1. Relative anomalies of the total monthly sunshine hours in the considered regions of Russia in 2021. [38]

Region	Month											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Russian Federation	92	98	98	99	100	107	106	101	99	108	96	104
Center and South of Western Siberia (including Tyumen)	125	111	91	103	111	96	99	104	106	106	86	97
Northwestern Federal District (including St. Petersburg)	73	126	111	97	93	126	117	97	95	112	72	117

As was previously mentioned, contact of sunlight with human skin triggers a reaction in the body, which results in the production of the hormone 1,25-dehydroxyvitamin D3, which is actively involved in mineral metabolism.

As the weather dynamics data suggest, a difference in geographical location of several degrees plays an important role. In St. Petersburg (Northwestern District), the number of solar hours is significantly less than in Tyumen (Southwestern Siberia). This means that at the nutritional level there is a greater need for 1,25-dehydroxyvitamin D3 stimulating drugs in this area.

St. Petersburg is a seaport metropolis with several port zones, a marine terminal, an oil terminal, and developed river transport. The main source of drinking water for the city is the Lake Ladoga basin, from which the Neva River originates, which is the only source of drinking water in the city (98% of drinking water). Tyumen is a river city, the water transport of which is represented by river navigation and tourist boats. Drinking water is also obtained from the river waters of the Tura River, or from water intakes surrounding the city. Accordingly, the level of pollution of water areas is incommensurable. Water quality in St. Petersburg is under the jurisdiction of the Federal State Budgetary Institution “North-Western Administration for Hydrometeorology and Environmental Monitoring” [49, 99]. Water is collected for hydrochemical analyzes at 18 water intakes in St. Petersburg and the Leningrad region.

As of Tyumen, responsibility for these activities lies with Tyumen Vodokanal LLC [96], and the Center for Hygiene and Epidemiology analyzes water samples in the Tyumen Region [122]. Summing up, we could conclude that the hydrological situation in St. Petersburg and adjacent settlements is less favorable.

As stated in the first chapter of current study, chronic rhinitis and nasal congestion are common precursors to a number of orthodontic pathologies. Reduced airway patency leads to forced mouth breathing, which negatively affects both orthodontic health and general somatic condition. A number of studies were conducted in the Russian Federation, the purpose of which was to monitor the growth of primary morbidity of a particular organ or organ system and determine the level of general morbidity [43]. Acute and chronic respiratory diseases are of particular interest in the context of this study.

Based on the data obtained during the research, we drew two important conclusions:

1) an increase in primary respiratory morbidity among the study population in the period from 2000 (46,170 thousand cases) to 2020 (54,273 thousand identified cases) (Rosstat), this may indicate a number of reasons – accessibility of healthcare and, as a result, more frequent visits to doctors about the disease, a sufficient number of pediatricians and local doctors in the staff of public health institutions, a decrease in the level of general somatic health of the population as a whole.

2) diseases of the respiratory tract prevail over all diseases of other organs and systems; in some populations, the prevalence of such diseases can reach 30% or higher [178]. This trend can be explained by the anatomical features of both the organs of the nasopharynx and maxillary sinuses, and the filtering functions of these organs, which are also gateways for the penetration of infectious agents. Combined with the information provided in the ‘Literature Review’ chapter we could conclude that there is a predisposing factor for the massive development of a number of malocclusions.

2.2. Research methods

During the practical realization of current study, authors closely followed the deductive principle ‘from general to specific’ in accordance with the goals and objectives. Therefore, a checklist was developed for each stage of the study.

Table 2. Stages of the research

Name of the research stage		**Sample size (number of people)**	**Research method and used tools**
Clinical methods	1. Research and assessment of the dental status of children, determination of the DMFT index (decayed, missing, filled teeth)	1874	Clinical dental examination
	2. Research and assessment of orthodontic status, the prevalence of various forms of DFA, determination of the need for orthodontic treatment.	1874	Clinical examination by an orthodontist
Laboratory diagnostic methods	3. Research on various methods of plaster control and diagnostic models, the type of closure of the patient’s jaws, development of preliminary treatment tactics	1874	Casting models from class IV plaster. Analysis of models using the Andrews and Pont method.
X-ray methods	4. X-ray studies (CT, TRG in various projections, orthopantomography)	1874	Assessment of the condition of the dental system using OPTG and CT. Analysis of TRG using the Schwarz method.
Sociological methods	5. Organization and realization of research on awareness and level of dental knowledge among parents (legal representatives)	608	Survey of parents (legal representatives) using a questionnaire developed by the author (refer appendix)
	6. Assessment of children’s attitudes and their motivation to orthodontic treatment.	1243	Survey of children using a questionnaire developed by the author (refer appendix)

The table reflects the materials and methods used during current work. The compilation of mentioned algorithms allowed to organize the workflow, both during the actual writing and during the presentation and discussion of the acquired data.

2.2.1. Clinical research methods

The clinical study consisted of several stages: a general dental and orthodontic examination of children and their parents who took part in the study. The classification of occlusion anomalies by L.S. Persin (1989) was used due to it being recommended by the resolution of the twentieth congress of the Professional Society of Orthodontists (POS) of Russia (2006) as a unified classification in orthodontic and orthopedic clinics, supplemented by the classification of anomalies of teeth and jaws recommended by the Department of Orthodontics and Pediatric Prosthetics of the Moscow State Medical University (1990). The main group underwent the same series of assessment.

The methodological essence of current work was based on picking proper clinical, statistical and organizational research methods to achieve set study goals.

A set of generally accepted techniques was used in the dental examination: questioning, examination, palpation, assessment of periodontal tissues and teeth condition and local status. A general clinical and life anamnesis was also collected to identify chronic diseases.

Patients' examinations were carried out in an outpatient clinic based in the dental department of the State Budgetary Healthcare Institution "Regional Hospital no. 19" (Tyumen) and the State Budgetary Healthcare Institution of the State Children's Hospital no. 6 (St. Petersburg). The study period lasted from January 2018 to October 2022. The doctor office in both medical institutions met the sanitary and hygienic requirements of SanPiN, including illumination standards.

A set of examination instruments was used when conducting an examination of oral cavities, consisting of a viewing mirror and a dental probe. The first stage of the assessment was the examination of the perioral organs and tissues, which corresponds to the generally accepted method of dental examination (decree of the Ministry of Health and Social Development of the Russian Federation no. 1496n 'On approval of the

Procedure for providing medical care to the adult population for dental diseases', December 7, 2011).

Examinations were carried out in accordance with rules of medical ethics and deontology.

A survey included collecting information about complaints, illness and life anamnesis and previous orthodontic treatment. When communicating with parents, the peculiarities of teething, the nature of feeding, the presence of bad habits and chronic diseases in early childhood were specified. Collecting an anamnesis of the disease consisted of finding out the time when certain abnormalities were first discovered noticed by parents and possible causes as seen by them [81]. It was specified whether relatives had malocclusions and if the parents had undergone orthodontic treatment.

A general examination of a child included an assessment of physical development and how appropriate it is for the child's age. Particular attention was paid to determining the stage of growth of the child (when studying TRG), the presence or absence of pathologies of the musculoskeletal system, and the status of the muscles of the shoulder girdle and neck. During the examinations, special attention was paid to children with various forms of pathological curves of the spinal column, since, due to their physiological characteristics, they are at risk of orthodontic pathologies [28, 60].

An examination of the facial area was carried out with patients sitting and standing, and the symmetry of the facial parts was assessed, as well as face shape from the frontal view and the type of profile (convex, concave, straight). The lymph nodes of the maxillofacial area were examined by palpation, and the skin turgor was determined. The condition of the hard tissues of the teeth, periodontium, attached and free mucosa, as well as the tone and condition of the muscles of the oral cavity (cheeks, tongue, lips) were assessed using an examination kit (mirror, probe). The presence of occlusion and the relationship between teeth and dentition were assessed as well [80].

Malocclusion is a dental disease, therefore criteria and characteristics of all diseases in general apply to it. Disease, as defined by Gould's medical dictionary [184], is the inability of the body's adaptation mechanisms to adequately withstand stimuli and stress acting on it, as a consequence, causing disruption of the function or structure of

any part of an organ or system of the body. From here, we see the rationale for applying a systemic approach to DFA, which will also include inspection and assessment of systems and organs associated with DFA. These include the temporomandibular joint and ENT organs [95, 116, 117].

Inspection and assessment of TMJ function was carried out as well. According to the generally accepted point of view proposed by domestic authors Lebedenko I. Yu., Arutyunova S. D., Antonik M. M., Abolmasova N. N., Petrosov Yu. A., [13, 10, 2, 85, 86] occlusal disorders are interpreted as the main etiological factor leading to a compensated or decompensated form of dysfunction of the stomatognathic system. Palpation and phonoarthrography techniques were used for the study. Palpation of the TMJ was carried out through the skin, according to anatomical landmarks. The main goal of the palpation assessment technique is to determine the localization of a particular TMJ anomaly. The establishment of actual sound characteristics is carried out using phonoarthrography [84, 68, 32]. This study was carried out using a stethoscope.

Examination also included assessment of breathing, swallowing and speech functions. A viewing mirror was used to study nasal breathing function. Exhaled warm, moist air condenses on the surface of the instrument, forming visible condensation spots [78, 87]. The assessment of swallowing function was carried out using a swallowing test, which boiled down to determining the time during which the patient was able to swallow a bolus of food or liquid (saliva). Normally, the swallowing time for liquid food is approximately 0.2 seconds and 0.5 seconds for solid food. In case of improper swallowing, the increase in the time of the act is due to both improper functioning of the TMJ and muscles (the teeth in this situation are usually not closed). Recognizing speech disorders, as a rule, is not difficult, and most often the parents themselves indicate this during the collection of anamnesis. Often, incorrect speech depends not so much on the child's dental anomaly itself, but also on the functional characteristics of the lingual muscle [82, 83].

A dental examination and interview of children and their representatives allowed to collect information about the current local status of malocclusion, identify the etiological factors of its occurrence, assess the presence and severity of concomitant

pathology leading to aggravation of the condition of the malocclusion, draw up a preliminary plan for medical procedures, including planning consultations from related specialists.

During a visual examination of the face, the parameters were studied in frontal and side views. To visually assess the shape of the face, the Izard index was used [176] – it was determined by the ratio of the height of the face (straight oph-gn) to the width (zy-zy). The facial profile was assessed by its appearance (concave, straight and convex) and determined considering the location of the upper and lower lips in relation to the Ricketts plane. The protrusion of the lower lip was assessed as a convex profile, and the distance as a concave profile.

The ICON index [133] was used to assess the need for orthodontic treatment [169] during clinical examinations. Evaluation of a clinical case using this index allows one to quickly determine the presence and roughly assess the severity of DFA directly during examination of the patient, or during the assessment of plaster models of the jaws [125].

The classic ICON index consists of 5 components with corresponding indicators assigned to them [133].

Component I – aesthetics assessment. Aesthetics are assessed using the IOTN aesthetic index scale [149], which reflects the status of the permanent dentition. The doctor determines overall attractiveness by visually assessing either patient’s facial features during the examination or from photographs. The rating scale ranges from 1 to 10, where 1 is the most attractive appearance, and 10 is the least attractive. Next the indicator of the aesthetic component is multiplied by 7.

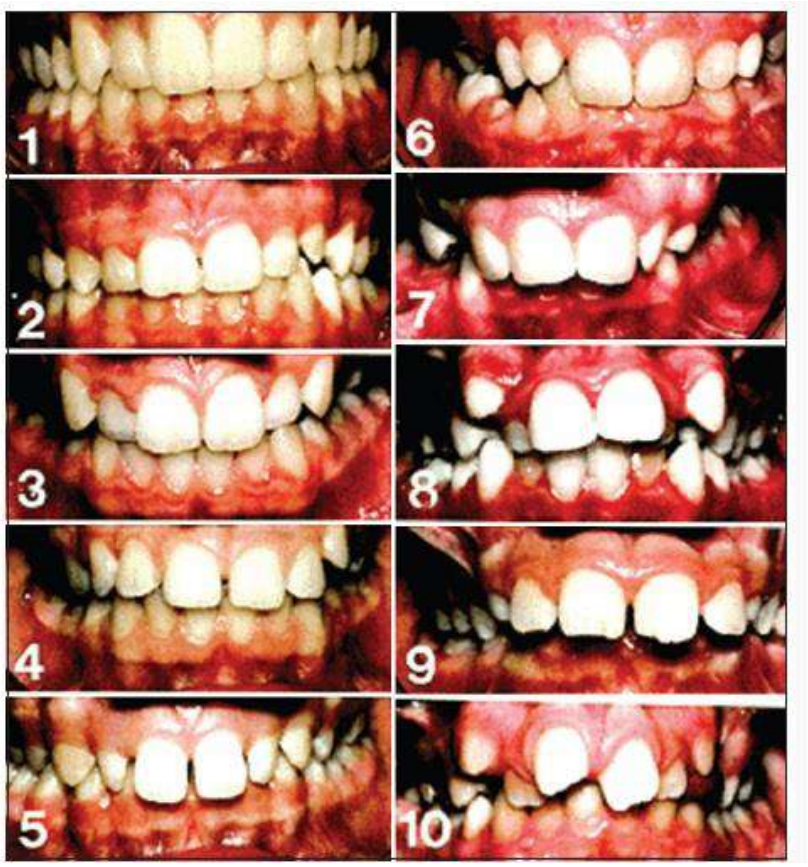


Fig. 2. Aesthetic scale for assessing the patient's occlusion severity using IOTN index [160]

Component II – presence of crowding, diastemas and tremas. To determine the deficit or surplus of space in the dentition, measurements of the teeth mesiodistal dimensions are taken. The information obtained is compared with tabular data and the resulting indicator is multiplied by 5. If the dentition contains unerupted teeth, with the exception of the third molars, then the highest score of 5 is designated.

The temporary teeth remaining in the dentition without the rudiments of permanent teeth and the erupted supernumerary teeth are considered three. Teeth lost as a result of injuries and complications of caries are also calculated.

Component III – presence of crossbite. Normally, the buccal cusps of the upper molars and premolars overlap the buccal cusps of the antagonist teeth, and the palatal cusps of the upper teeth are located in the longitudinal fissures of the lower ones. A crossbite is diagnosed when there is direct cuspal contact or a complete cuspal buccal or lingual discrepancy involving a single or multiple teeth. In the anterior section, the relationship is considered a crossbite when there is direct contact of the canines and

incisors or their reverse overlap. When a crossbite is discovered, 1 point is assigned and multiplied by 5.

Component IV – presence of vertical incisal disocclusion or deep incisal overlap. The vertical gap is measured at the deepest point between the cutting edges of the anterior teeth using a millimeter ruler. When determining the depth of the overlap, one should measure its deepest part. The data is compared with table values to determine the score, which is then multiplied by 4.

Component V – assessment of the fissure-tubercle relationship in the lateral group of teeth. The fissure-tubercle contact of canines, premolars and molars is assessed in accordance with the protocol (refer Table 3) for each side separately, and scores are summed up afterwards. Zero points are given when there are multiple fissure-tubercle contacts of the lateral group of teeth; 1 point – in cases of any relationship in the lateral group, excluding direct tubercular contact; 2 points – in cases of direct tubercular contact of the lateral group of one or multiple teeth. The score is multiplied by 3.

Table 3. Checklist for results assessment using the ICON method [169]

Index component							
	0	**1**	**2**	**3**	**4**	**5**	**Coeffi cient**
Aesthetic	**1 to 10 scale**						
Crowding	<2 mm	2,1-5,0 mm	5,1-9,0 mm	9,1-13,0 mm	13,1-17,0 mm	17,0 mm	5
Tremas	<2 mm	2,1-5,0 mm	5,1-9,0 mm	>9,0 mm		Impacte d teehth	5
Crossbite	Absent	Present					5
Open bite	Proper open bite	<1 мм	1,1-2,0 мм	2,1-4,0 мм	>4 мм		4
Incisor overlap	Overlap of less than 1/3 of lower incisors	1/3 to 2/3 overlap	Less than 2/3 overlap	Full overlap			4
Bumprock contact	Fissure-bumprock contact (class I, II, III)	Any contact except for bumprock	Bumprock contact				3

The sequence of calculating the received data on the ICON index is as follows:

- assessment and evaluation of all components;

- multiplication of each score in accordance with the coefficient;

- summation of all multiplied values, resulting in an ICON index value;

Examination of a patient prior to treatment allows one to assess the severity of DFA, and post-treatment evaluation allows one to assess the quality of treatment and its outcome.

Interpretation of the results according to the final score is explained below:

- ICON value > 41 – the threshold value of the index indicates the need for orthodontic treatment;

- ICON value < 31 – determines the acceptability of the emergency response state.

Based on the results, the degree of treatment complexity is determined: mild, moderate, average, severe or very severe.

Table 4. Interpretation of ICON indexing results [169]

The degree of orthodontic treatment complexity based on the ICON index	
Degree of treatment complexity	**ICON index value**
Mild	<29
Moderate	29-50
Average	51-63
Severe	64-77
Very severe	>77

The table demonstrated above is easy to use and allows one to quickly determine the severity of a patient's clinical situation.

As a result of conducting a mass assessment of examined children using the ICON indexing method, we were able to not only see the characteristics of a single malocclusion in each child in need of treatment, but to also assess the severity of DFA in a particular city or region [133]. Based on this, we concluded that this index makes it

possible to both identify the severity of malocclusions in children and the necessity of preventive measures and treatment, locally and regionally.

2.2.2. Laboratory diagnostic methods

In clinical and laboratory studies, diagnostic impressions were taken, and plaster models were cast using Zhermack alginate mass and Zhermack Elite Ortho respectively. Diagnostic impressions underwent antiseptic treatment according to generally accepted disinfection methods. The casts were soaked for 15 minutes in an ADS-521 solution, then washed with running water. The casting of plaster models took place in the dental laboratory in medical institutions – the research bases. Pre-dried impressions were filled with Elite Ortho grade 3 plaster, intended for creating models for orthodontic research. The gypsum was selected for compressive strength, environmental resistance and positive qualities for diagnostic work. Using plaster models resulted in the establishment of correct diagnosis. Number of parameters were assessed in the process – Engle class, depth of incisal overlap, mesiodistal dimensions of the teeth, length and width of the apical bases, width of the dentition, etc.

To conduct these studies, methods of biometric evaluation of plaster models of jaws were used. The following assessment methods allowed to determine topographic and morphological abnormalities in malocclusions and help in justifying a particular treatment plan. All biometric methods are based on regularities in the relationship between the sizes of teeth and dentition.

The main diagnostic method for picking plaster jaw models was the assessment of occlusion keys using the Andrews method – the technique proposed in the 1960s, who created unified criteria for assessing ideal occlusion based on the study of more than a hundred models with orthognathic occlusion. Six so-called occlusion keys have been proposed [153, 154]:

1. Correct fissure-tubercle contact between first permanent molars of the upper and lower jaws with proper longitudinal inclination of teeth axes to the occlusal plane. The mesiobuccal cusp of the first permanent molar of the upper jaw lies inside the fossa between the mesial and middle cusp of the first permanent molar of the lower jaw.

2. Mesiodistal inclination (angulation) of the crowns – with physiological occlusion, the gingival part of the lobar axis of the tooth is located somewhat distal to the occlusal part.

3. Vestibulo-oral inclination of teeth (torque) – torque is the vestibulo-oral inclination of the crowns and roots of the teeth, this angle is formed by a perpendicular to the occlusal plane and a tangent in the middle of the labial or buccal surface of the clinical crown of the tooth. In this case, the crowns of the teeth are located in such a way that the occlusal part is located more vestibular in relation to the apices of the roots of the teeth. It is also worth remembering that the torque of the frontal group of teeth directly affects the relationship in the lateral jaws. Correct, physiological torque means harmonious overlap and relationship of the molars.

4. Rotation of teeth. With an orthognathic bite, the dentition should not have teeth turned along its axis. Rotated molars and premolars take up more space in the dentition; when rotated in the frontal segment, the situation is opposite due to the peculiarities of the anatomical structure of incisors and canines: the rotated incisor takes up less space, which leads to crowding of the teeth.

5. Tight mesiodistal contacts. Normally there should be tight mesiodistal contact between the teeth, i.e. no tremas or diastemas. The contact between teeth occurs on the convex approximal surfaces, thus forming contact surfaces, or contacts. Contacts are localized in the upper third of teeth, closer to the cutting edge or to the chewing surface. It is worth noting that tight mesiodistal contact plays an important role in the integrity and functioning of the dental system – it leads to an even distribution of the chewing load and helps the connective tissue apparatus hold the tooth in the dentition.

6. Spee occlusal curve. The sagittal occlusal curve passes through the cusps of the posterior teeth and the cutting edges of the anterior group of teeth. In the 80s of the 20th century, Spee described this curve in detail. The distinctive feature of the occlusal curve is the convex shape of the upper jaw line and the concave shape of the lower jaw line, which allows even distribution of chewing pressure. During the act of chewing, the occlusal curve shifts; the lower jaw moves forward mesially, which leads to improper distribution of the chewing load in cases of malocclusion. The chewing load is

distributed between the upper and lower incisors and canines, while a gap is formed in the lateral segment. With an orthognathic bite, this deficiency is compensated by the shape of the dentition and the location of the upper and lower teeth relative to each other.

Another evaluation method is the Pont evaluation method, proposed by the author in 1909. It is used to determine the width of the dentition in the mixed and permanent dentition. Pont established a relationship between the sum of the mesiodistal dimensions of the incisors and the width of the dentition in the area of premolars and molars [231], which are expressed by two indices, premolar and molar – 80 and 64. This relationship is expressed in the following formulas:

Sum of width of four incisors * 100 / 80 = distance between first premolars

Sum of width of four incisors * 100 / 64 = distance between first molars [77].

The measuring topographic points are:

- for the upper jaw: the middle of the longitudinal fissures of the first premolars and the mesial point of intersection of the longitudinal and transverse fissures of the first molars;

- for the lower jaw: the distal point of the first premolar, which is the point of contact with the second premolar and the distal buccal cusp of the first molar.

These points are relevant for the permanent dentition; when assessing the mixed dentition, the distal dimples on the temporary molars on the upper dentition and their distal-buccal cusps on the lower dentition are determined instead. To simplify the implementation of this technique in practice, Pont compiled a table of values for the width of the dentition depending on the size of the incisors. There are a number of modifications of the Pont-index according to Linder-Hart and Snagina, the latter changed the index value to 85 and 65 [76].

The study algorithm using the Pont method is as follows:

1. Determine the width sum of four incisors (mesiodistal dimensions);

2. Insert the resulting amount into the Pont formula and set the index depending on the jaw being examined;

3. Find specific topographic points on both premolars and molars necessary to determine the true width of the dentition, take their measurements;

4. Compare the actual width of the dentition to the desired value;

5. Analyze the obtained data.

The Dolgopolova method was used to evaluate plaster casts of children with primary dentition. The diagnostic technique proposed by the author is used to assess the width of the dentition in children aged 3 to 6 years [76]. Topographic points are: the palatal tubercles of the second incisors and canines, the intersection points of the longitudinal and transverse fissures of the first and second molars.

Below is an algorithm for conducting research using Dolgopolova's method:

1. Find measuring points according to Dolgopolova

2. Measure the actual width of the dentition

3. Determine the sagittal size of the dental arch: measure the distance between the mesial edge of the crown of the central incisor and the anthropometric point on the second molar.

4. Compare the data with the average table values.

5. Interpret the result obtained.

Studies of jaw plaster models are an important source of information when developing a comprehensive orthodontic rehabilitation plan. Various methods for obtaining and interpreting this data make it possible to give a clear picture of both the intermaxillary relationships and the size of the dentition, which, together with other clinical research methods, allows both to prepare for treatment and to predict the approximate duration and outcome of medical manipulations.

2.2.3. X-ray methods

The X-ray examination included radiovisiography methods such as orthopantomography (OPTG) and teleradiography (TRG) in two projections, frontal and lateral. The studies were carried out at the dental department of the Regional Hospital No. 19 and the State Budgetary Institution of Emergency Situations No. 6 using digital orthopantomographs. This radiographic system allows for panoramic examination,

zonography of the TMJ, and teleradiography in various projections. The radiation dosage obtained during digital radiovisiography is minimal and equal to 20 μSv, which is significantly less than the norm proposed by SanPiN of Russia by about 50 times. This technique for visualizing the bones and tissues of the maxillofacial area is preferable to standard radiography for a number of reasons. Firstly, due to the digital output of the finished image and the ability to analyze it in specialized software, it becomes possible to offline store images without an analogue medium (film). Secondly, the low ionizing load – which is primarily due to the operating principle of the device – the X-ray is smaller in classical X-rays and, when passing through tissue, is immediately captured by a special sensor. The only disadvantage of radioviosiography is its low spatial resolution compared to the film; therefore, the difference between structures that differ significantly in density is often not conveyed. However, this disadvantage could be mitigated via software settings.

During the analysis of X-ray images of patients undergoing epidemiological orthodontic research, the algorithm for studying panoramic images (spiral orthopantomography) included the following:

1) Assessment of root resorption of primary teeth

2) Assessment of eruption of permanent teeth

3) Symmetry of the rudiments and existing teeth

4) Assessment of the condition of periodontal tissues

5) Symmetry of hard tissues of the maxillofacial area

The degree of resorption of the apical parts of tooth roots was assessed using the following parameters:

- Levander index (1988) [208] and included 4 degrees – I minimal, II minor resorption up to 25% of the root length, III moderate resorption (25-50%), IV significant resorption (50% of the root length) root and above)

- using the Vinogradova method, which suggests three types of resorption [23].

Table 5. Types of resorption (Vinogradova's classification)

Type 1	Type 2	Type 3
Even	**Uneven**	**Bifurcational**
Predominant in single-rooted teeth. Vertical type of resorption	Predominant in multi-rooted teeth Both one of the roots and the bifurcation are affected	A characteristic feature is the resorption of bifurcation combined with the integrity of root structures.

This table is easy to use clinically and allows you to quickly analyze the condition of the roots of teeth and adjacent periodontal tissues.

Assessment of the eruption timing and nature for permanent teeth in the mixed dentition was carried out using the Vander Linden Duterloo method (1976) [210]:

- eruption occurs in two stages;

- tooth growth comes from its corresponding bone crypt, and according to the physiological timing of teething characteristic of the age group of the surveyed population [74].

The symmetry of hard tissues was assessed using the midline and a graphical method for evaluating biological symmetry. To achieve this, points A and A1 were marked in the area of bifurcations of the first lower molars, from which straight lines were drawn in accordance with axes of said teeth to the intersection points in the area of the middle third of the face (B). Then the midline (L) was marked on the image, as well as the line connecting points A and A1 (C) and additional lines connecting the middles of the crowns of the upper and lower first molars, respectively (L1 and L2).

Fig. 3. Orthopantomogram image (courtesy of the author)

In cases of symmetry of hard tissues, a virtual triangle is formed by parallel lines C, L1 and L2 and so do two symmetrical triangles – ACB and A1CB.

Another standard orthodontic assessment method was TRG, carried out in two projections – frontal and lateral. A teleroentgenogram is one of the most informative research methods for a practicing orthodontist, allowing one to determine the essence of morphological changes in the maxillofacial area, including: the skeletal class of a particular clinical case, the position of the jaw bones, protrusion or retrusion of the frontal portion of the dentition, indications were identified to orthosurgical treatment methods.

The teleroentgenogram has proven its usefulness quite a long time ago; the shooting technique was proposed back in 1922 by the Italian anthropologist Paccini, and Broadment (USA) and Hofrath (Germany) were the first to use it in orthodontic practice in 1931 [4, 174, 175].

The standard teleradiography technique involves shooting at a considerable distance from the patient (1 meter 50 cm, exposure 0.1 s), since with this method of positioning the “X-ray tube-patient” the X-ray beams will be parallel to each other, which will avoid distortions during shooting. In this case, the head of the subject is fixed in a special device – a cephalostat, which in turn is connected to a stand for fixing the X-ray cassette. The X-ray tube is adjusted as follows: a number of authors recommend directing the central beam to the external auditory canal (Margolis), to the anatomical middle of the zygomatic arch (Hausser), to the area of the permanent first molar of the maxilla [186, 251].

We chose to follow the methodology of S.I. Doroshenko (1968) [4], who recommended centering the X-ray beam on the temporomandibular joint, slightly anterior to the tragus of the ear, during the study. This technique was chosen based on the ease of setting up the device and because of the proximity of the point proposed by the author to the anatomical center of the human head, which allowed the minimization of errors during the study.

After taking an X-ray image, the next step was to determine a number of anatomical landmarks based on the chosen method for evaluating the images. To date, many proprietary methods for calculating and interpreting TRG data have been proposed and are actively used in practice.

Calculations and analysis were carried out digitally using Mavecloud (https://mavecloud.ru, certificate of state registration of a computer program No. 2019619264) and Dolphin Imaging software in the Picasso X-ray centers using the classical Schwarz method, which was chosen due to its accessibility for analysis and calculation of the obtained anthropometric data. A.M. Schwarz [255] was the first to note that anatomical region of the upper and lower jaws is limited from the skull by the spinal plane. Based on this, he divided the maxillofacial region into two sections – the gnathic part, which includes the alveolar part of the jaws with the dentition, and the cranial part, located above the spinal plane, adjacent to the base of the skull. Schwarz, in his method of image analysis, identified several categories of anatomical landmarks:

- bone formations;
- soft tissue formations;
-plane landmarks.

Dividing anatomical landmarks into bone and skin makes it possible to exclude the researcher's subjective view of the patient's profile from the interpretation of study results. Planar (gnathological) landmarks make it possible to establish the morphological features of various types of dentoalveolar anomalies and their degree of severity.

Main anthropometric landmarks and points used in the Schwarz analysis are listed below:

1. Osseus landmarks:

N (nasion) – bone nasion, the transition point between the nasal and the frontal bones;

Se (sela turcica) – projection of the entrance mid-point of the sella turcica;

Or (orbitale) – point corresponding to the middle of the lower orbital margin;

Po (pogonion) – projection point of the articular head of the TMJ anterior to the external auditory opening;

Fpp (fossa pterygopalatina) – pterygopalatine fossa;

Sna (spina nasalis anterior) – medial point of the anterior nasal spine;

Snp (spina nasalis posterior) – the most distal point of the posterior nasal spine;

A – point corresponding to the most concave part of the alveolar process of the upper jaw under Sna;

pd (palatinum durum) – hard palate;

vp (velum palatinum) – soft palate;

ii – point of the middle of the interincisal overlap;

mm – point of contact of the closure of the first permanent molars;

B – point corresponding to the most concave part of the alveolar process of the mandible above Pgo;

Pgo (pogonion) – the most protruding point of the chin;

Gn (gnation) – point corresponding to the lower edge of the chin;

Go (gonion) – the point corresponding to the lower edge of the angle of the lower jaw.

2. Skin landmarks

tr- point of projection of the hairline on the forehead;

o – projection of the lower orbital margin onto the skin;

n – cutaneous nasion;

sn – subnasal region;

gn – cutaneous gnathion;

pgo – cutaneous pogonion;

3. Planes and reference lines:

MSe – plane of the base of the skull (cranial plane), corresponds to a line drawn through N and Se;

H – Frankfurt horizontal, a plane drawn through the points or and Po;

NA – facial plane drawn through points N and A;

SpP (spinale planum) – spinal plane, a line drawn through the points Sna and Snp, the plane of the base of the upper jaw;

OcP (occlusion planum) – occlusal plane, a line drawn through points ii and mm;

MP (mandibulum planum) – lower jaw plane, corresponds to a line drawn through the points Gn and Go;

A – tangent to the posterior edge of the lower jaw from the distal surface of the articular head to the distal surface of the angle of the lower jaw;

Pn (planum nasalis) – nasal plane, corresponds to the perpendicular to the NSe plane at point n;

Po (planum orbitalis) – orbital plane.

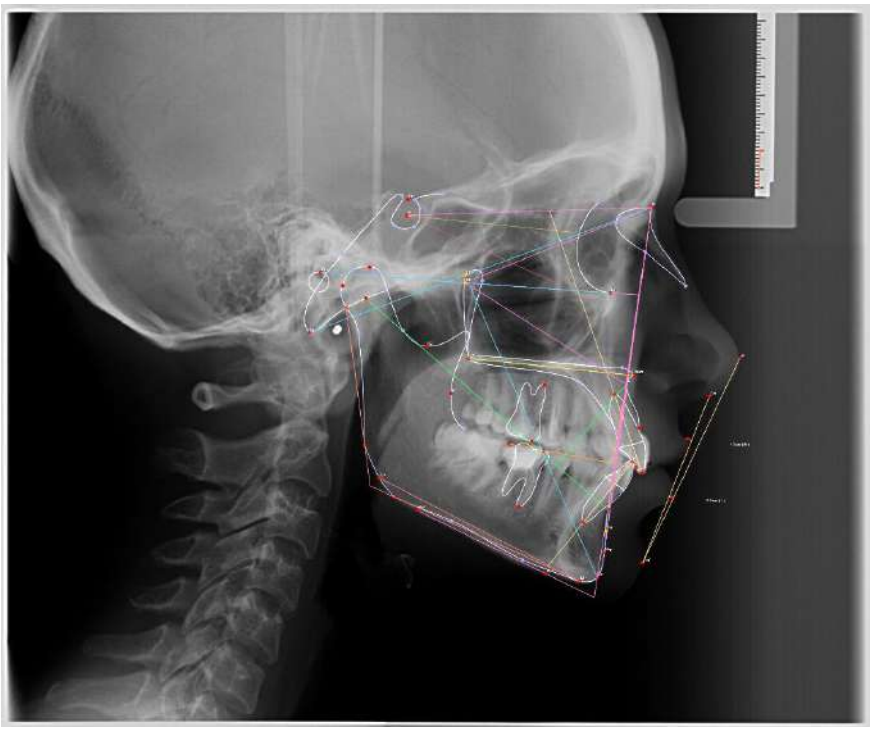


Fig. 4. Teleradiogram in lateral projection (courtesy of the author)

As figure above shows, the teleradiographic study makes it possible to evaluate not only the nature of growth and relationships of bone structures, but also their effect on the soft tissues of the maxillofacial area. This research method is useful not only in drawing up a treatment plan. TRG allows you to correctly formulate the patient's diagnosis, determine the nature of one or another form of bite pathology, and the stage of bone growth. Also, this method of x-ray examination, when carried out over time,

makes it possible to monitor the nature of changes during treatment and, as a result, adjust the treatment plan.

2.2.4. Methodology of sociological studies

The survey method is a psychological verbal-communicative method in which a specially designed list of questions – a questionnaire – is used to collect information from the respondent. In sociology, this method is used to compile static (one-time survey) or dynamic (repeated survey) statistical ideas about the state of society, public opinion, the state of political, social and other tensions in order to predict actions or events.

The questionnaire method allows minimal contact between the researcher and the respondent, in contrast to interviewing. Survey allows you to follow the planned research plan most strictly, since the "question-answer" procedure is strictly regulated.

Using the survey method, one could obtain a high level of mass research at the lowest cost. A special feature of this method is its anonymity (the identity of the respondent is not recorded, only his answers are recorded). Questionnaires are carried out mainly in cases where it is necessary to find out people's opinions on certain issues and to reach a large number of people in a short period of time.

With the growing popularity of the Internet, online surveys are becoming an increasingly popular method of collecting data. The design of online questionnaires often influences the outcome of the survey. Such design factors include the quality of questionnaire administration, available formats for presenting data (questions), methods of administration, elaboration and ethical components of the questionnaire. A number of sites provide a free opportunity to create an online questionnaire and collect data.

Advantages of the questionnaire method:

1. The ability to interview a large number of respondents at once at their place of work/study, as well as in crowded places;

2. Strict regulation of the procedure, which allows to obtain well-structured and comparable results;

3. The anonymity of respondents, which increases the objectivity and sincerity of the responses received, and also makes it possible to address sensitive topics;

4. Relatively low labor intensity of the procedures for preparing and conducting research;

5. Lack of influence of the personality and behavior of the interviewer on respondents;

6. The ability to offer visual handouts to the respondent for evaluation.

A questionnaire was designed to assess the quality of orthodontic treatment intended for orthodontists (“Current state of the prevention and treatment of malocclusions”). The questionnaire consisted of 16 questions and was designed with various aspects of preventive manipulations and current orthodontic correction techniques in mind. Includes questions allowed the researcher to evaluate the length and experience of the clinician, analyze the types of diagnostics used by doctors, the methods of their practical use and preventive work.

Based on the results obtained, an analysis and assessment of the work of dentists was carried out in order to determine the methods used for diagnosing and treating malocclusions and the level of professional training of orthodontists.

Clear data on certain points was obtained as a result of interpreting the questionnaire: the professional level of practicing doctors, their view opinion on prevention and diagnosis methods, collecting an anamnesis of the disease, making a diagnosis, choosing and justifying a treatment method, designing a primary and alternative treatment plan, assessing the quality and treatment results, determination of rehabilitation periods, possible complications of treatment. Also, the dentists’ opinions on each specific nosology, its localization, clinical manifestation and course of occlusion pathology, as well as their view on the condition of the oral cavity, methods, techniques and additional treatments techniques in the workflow were clarified.

A questionnaire for patients undergoing orthodontic treatment was also introduced and tested (“Prevention and treatment of malocclusions”), compiled for patients and their parents (legal representatives). The questionnaire for parents and included 22 questions aimed at identifying the causes of occlusion anomalies,

predisposing factors for the development of these anomalies, finding out the attitude of parents and the child to the prevention and maintenance of oral health, and identifying the social status of the family. The children counterpart included 16 questions, which were designed to help us identify the child's motivation for treatment, understand psycho-emotional state against the background of the presence of pathology associated with facial aesthetics.

The following goals were set for this research method:

- to determine the clinical experience of the doctors who took part in the study;
- to analyze the preventive methods used by doctors;
- to determine the level of knowledge and degree of involvement of related specialists;
- to identify the level of public awareness about the causes of malocclusions and methods of their prevention;
- to estimate the awareness of the importance for early orthodontic correction of pathological occlusion;
- to assess the level of knowledge about further development and complications in the absence of treatment, treatment methods used, assessing the level of knowledge about oral hygiene during orthodontic correction.

IBM SPSS Statistics 22 software package was used to process and analyze the results. Data processing included deleting invalid observations, working with missing values, as well as categorizing some variables with interval scales into ordinal ones. The next stage was the conclusion and analysis of frequency tables demonstrating the linear distribution of respondents' answers to the main questions of the questionnaire. The data obtained, characterizing general trends in the opinions and attitudes of the respondents, were described and interpreted. Next, based on the objectives of the study, contingency tables were constructed to study the difference in responses in various socio-demographic groups, as well as in terms of other differentiating characteristics. This allowed us to study the specific behavior of the object of our study regarding dental aspects of health in more detail. The probability of association between variables was determined based on the significance using the Pearson chi-square test.

Sampling process. We determined the size of the sample population based on the data of the ‘classical’ methodology by V.A. Yadov [140], in which he provides a table comparing the size of the general population and the corresponding volume of the sample population required to obtain representative data. According to this table, a sample size of 400 respondents represents a population that tends to infinity with a sampling error of 5% and a confidence interval of 95%. Noteworthy, online calculators commonly found on various social research sites refer to the same values.

CHAPTER 3. OWN RESEARCH

3.1. Comparative characteristics of prevalence and severity of bite pathology in St. Petersburg and Tyumen

In the process of writing current work, the goal to prove the necessity to formulate criteria for creating a prophylaxis program for malocclusions was set, as well as the necessity to implement the above-mentioned program into the workflow of orthodontists in order to improve the state of children's dental health. The main motivation behind developing this program is to decrease the prevalence of various malocclusions in children and adolescents. In the 'Literature Review' chapter we presented the morbidity pattern, etiological factors, pathogenesis are described in detail, information on concomitant pathologies and predisposing factors. Another important reason, in our opinion, was the presence of a general somatic pathology in a child or group of children, which is either the result of DFA, or its cause, direct or indirect. In this case, both edentulism of temporary and permanent teeth is an issue, as well as changes in the tone of the muscles of the maxillofacial area, incorrect posture and changes resulting from disruption of the respiratory system. This is mostly reflected in the paragraph 'Etiology and pathogenesis of malocclusions'.

To clearly understand the incidence of malocclusions, a group of children was studied using generally accepted dental examination methods, which is described in the 'Research Methods' paragraph [134].

Clinical dental examinations were conducted in two regions – Tyumen and St. Petersburg – in order to study the prevalence of malocclusions during the study period of January 2018 – October 2022 on the basis of the State Budgetary Healthcare Institution OKB No. 19 [134] and the State Budgetary Healthcare Institution 'City Children's Clinic No. 6' respectively. A total of 1874 children were examined; 120 doctors (orthodontists), 423 children and 411 parents agreed to take part in the sociological study.

As a result of clinical examinations, we discovered that malocclusions in one form or another were present in 549 children (56.8%) in Tyumen and in 578 children

(63.72%) in St. Petersburg. According to the data obtained, the greatest prevalence of the anomaly was observed among the preschool and primary school group of children (the highest rates are 83.2% (84 children) among 8-year-olds in Tyumen and 84.9% (79 children) among 6-year-olds in St. Petersburg). Boys tend to have higher incidence – 57.45% among children with malocclusions in Tyumen and 60.72% in St. Petersburg. Also, we discovered the number of children who were undergoing orthodontic treatment at the time of the study – 23.3% of the examinees in Tyumen and 35.2% in St. Petersburg. The need for orthodontic care in the two regions was determined to be 76.7% and 62.6%, respectively [126, 134].

Gender dimorphism of malocclusions was not clearly expressed and was represented by the following figures: 52.9% of 967 examined were girls (512) in Tyumen with incidence of 46.8% (257). 53.2% (242) of males had malocclusions (Figure 5).

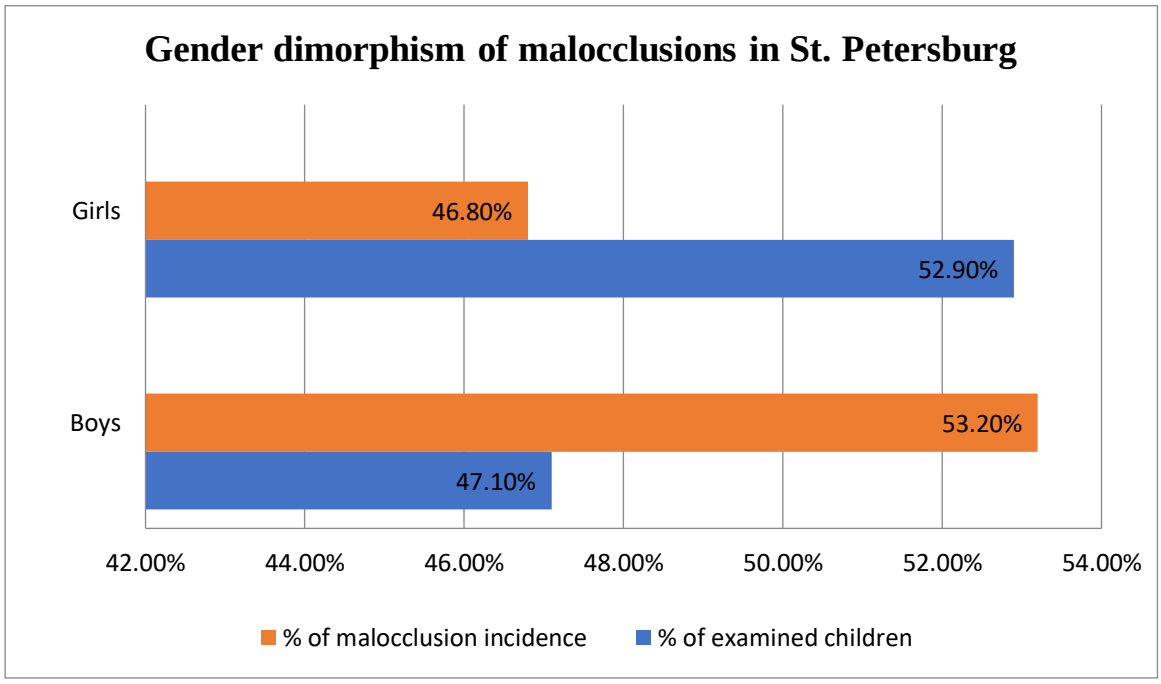


Fig. 5. Gender dimorphism of malocclusions in Tyumen

52% (472) and 48% (455) of examinees in St. Petersburg were females and males respectively (Figure 6). Malocclusion incidence rate was 40.65% (235) among girls and 59.35% (343) among boys. To sum up, the sexual dimorphism in these regions was smoothed out and did not play an important role in the prevalence of DFA [126, 134].

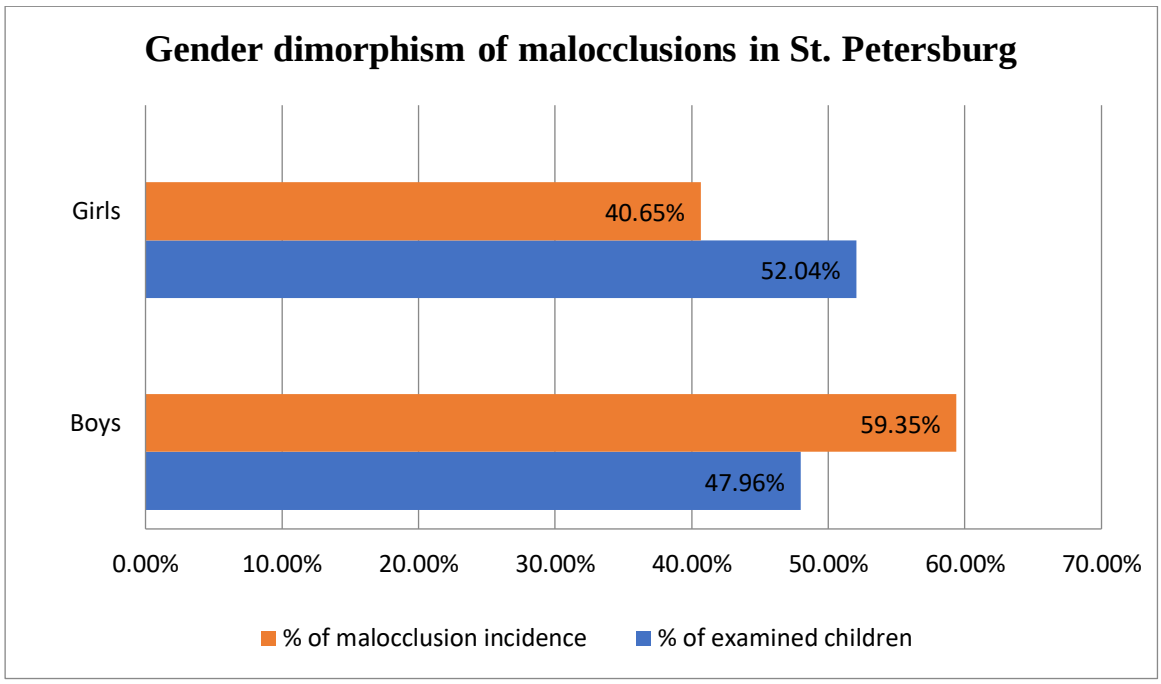


Fig. 6. Gender dimorphism of malocclusions in St. Petersburg

An analysis of malocclusions' nosological forms in the examined population was also carried out. Anomalies of individual teeth according to Engle's class I (Figure 7) were found in 38.98% (214) (Tyumen) and 30.27% (170) (St. Petersburg), open bite with neutral closure in the lateral sections (traumatic form) in 0.91% (5) (Tyumen) and 1.4% (8) (St. Petersburg), crossbite in class I – in 2.73% (15) (Tyumen) and 3.8% (22) (St. Petersburg) of the examinees.

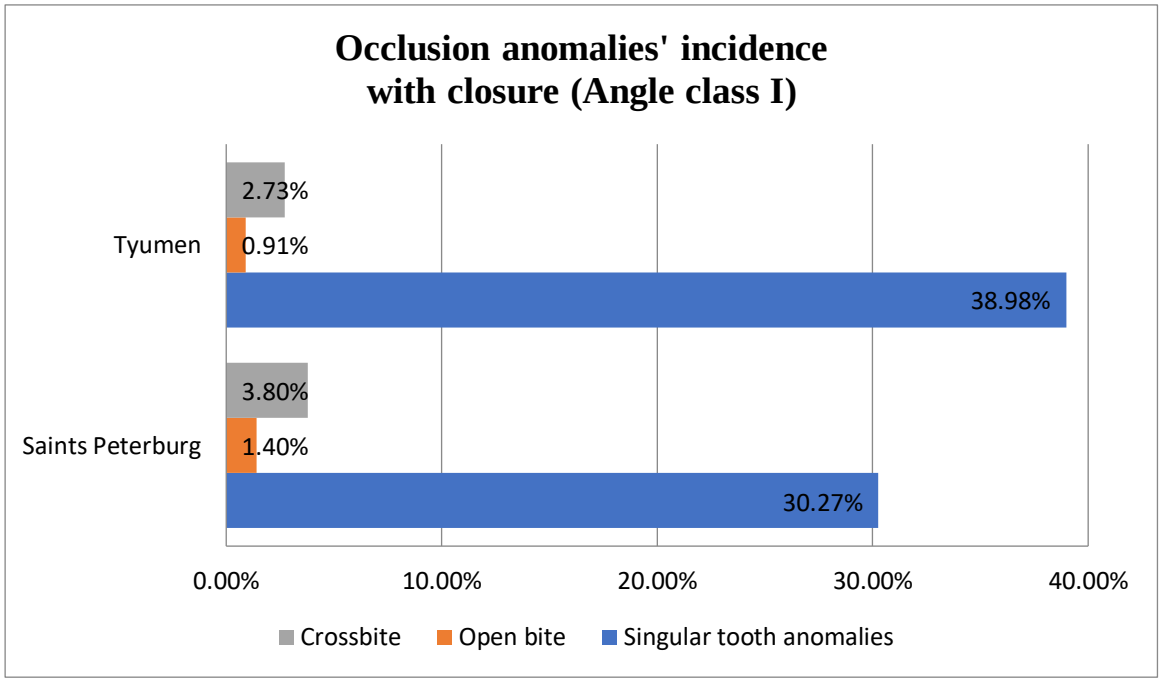


Fig. 7. Incidence of occlusion anomalies
with interlocking (Angle class I)

Class II closure (Figure 8, Figure 14, Figure 15) without visible significant associated pathologies was observed in 7.47% (41) (Tyumen) and 15% (89) (St. Petersburg) of the examinees, while the total proportion of children with class II anomalies (including combined forms with dental anomalies, traumatic open bite and crossbite) was 36,07% (198) (Tyumen) and 25,78% (149) (St. Petersburg) [126, 134].

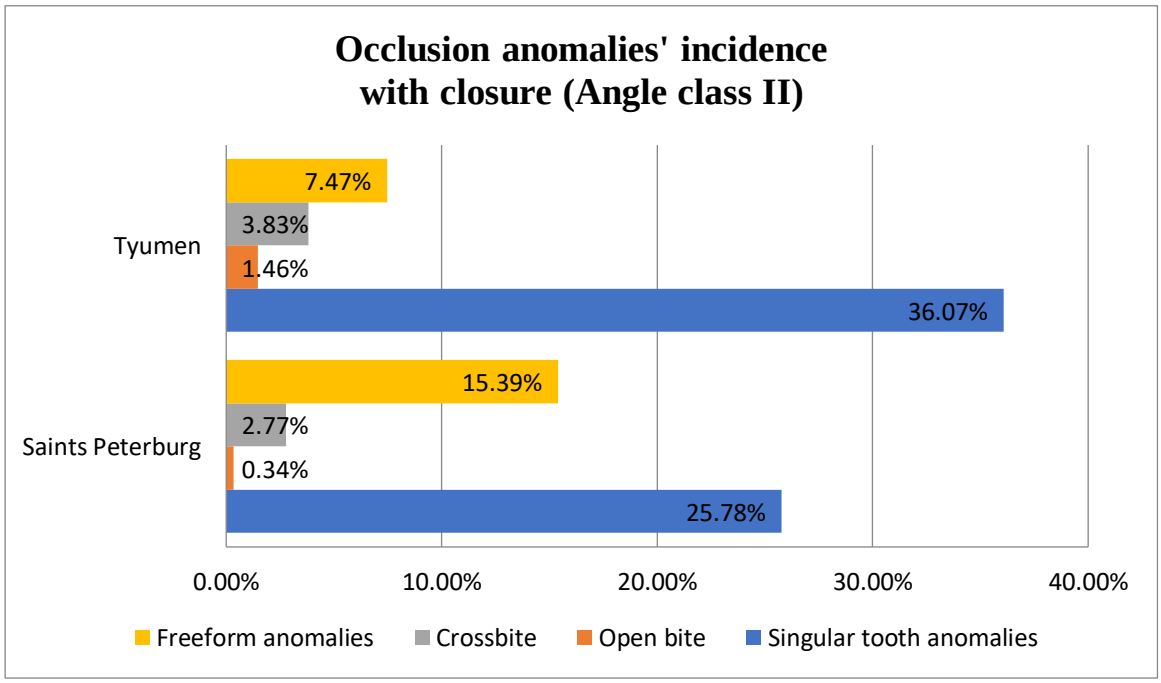
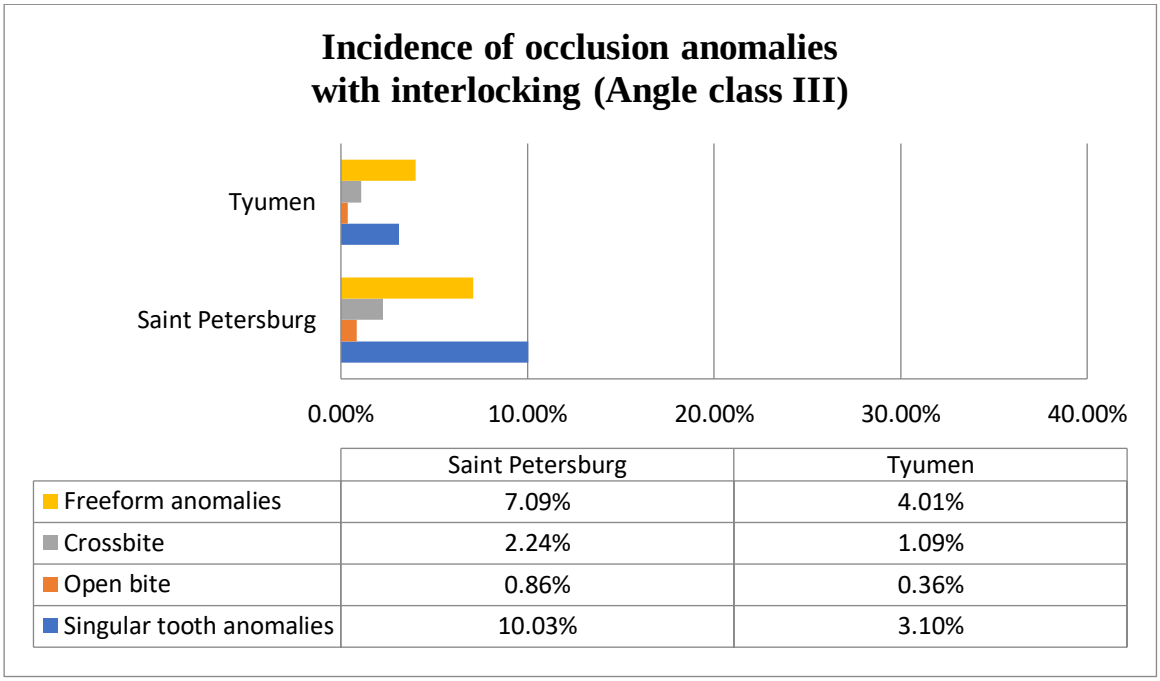


Fig. 8. Incidence of occlusion anomalies with interlocking (Angle class II)

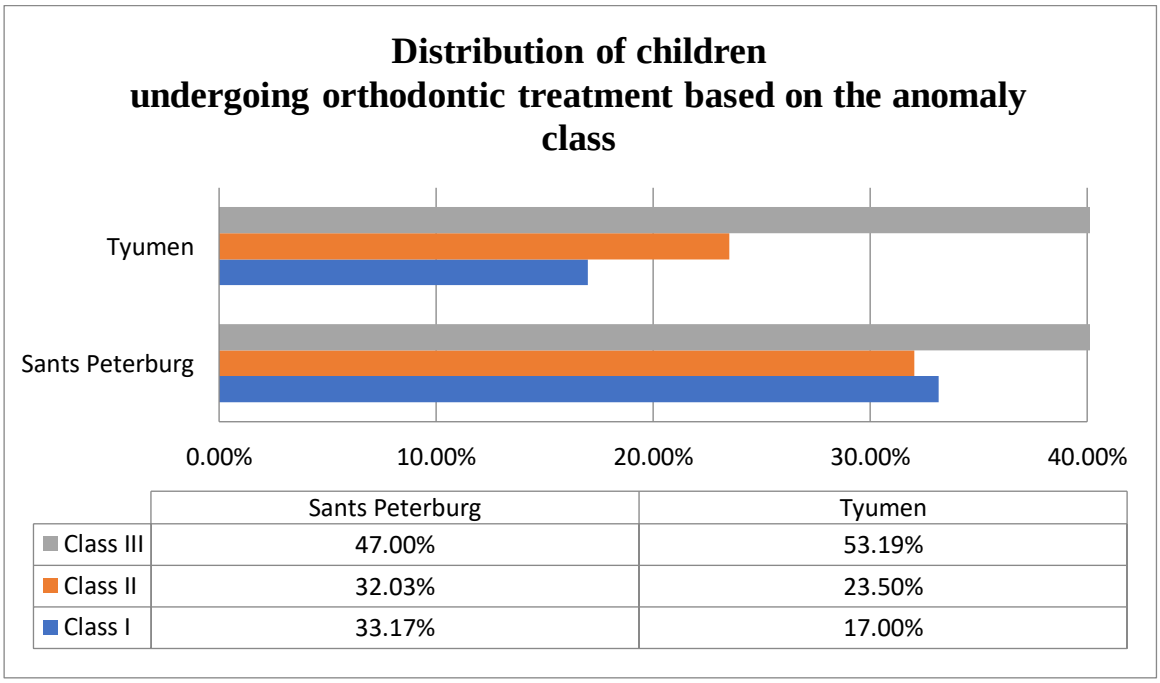
The number of children with class III closure was discovered in 8.56% (47) (Tyumen) and 20.2% (117) (St. Petersburg) of the examinees (Figure 9, Figure 16, Figure 17). Among those the percentage of patients with individual teeth anomalies were 3.1% (17) (Tyumen) and 10.03% (58) (St. Petersburg), open bite with mesial closure was found in 0.36% (2) (Tyumen) and 0.86% (5) (St. Petersburg) of cases, cross closure – in 1.09% (6) (Tyumen) and 2.24% (13) (St. Petersburg), mesial occlusion without significant concomitant pathologies – in 4.01% (22) (Tyumen) and 7.09% (41) (St. Petersburg)[126, 134].



	Saint Petersburg	Tyumen
Freeform anomalies	7.09%	4.01%
Crossbite	2.24%	1.09%
Open bite	0.86%	0.36%
Singular tooth anomalies	10.03%	3.10%

Fig. 9. Incidence of occlusion anomalies
with interlocking (Angle class III)

During the examination of children in both cities we formed a group of people undergoing orthodontic treatment at the time of the study (Figure 10). This group included 23.3% (128) of the total number of children with DFA, and 35.29% (204) in St. Petersburg. We then studied the structure of morbidity in said group.



	Sants Peterburg	Tyumen
Class III	47.00%	53.19%
Class II	32.03%	23.50%
Class I	33.17%	17.00%

Fig. 10. Distribution of children
undergoing orthodontic treatment based on the anomaly class

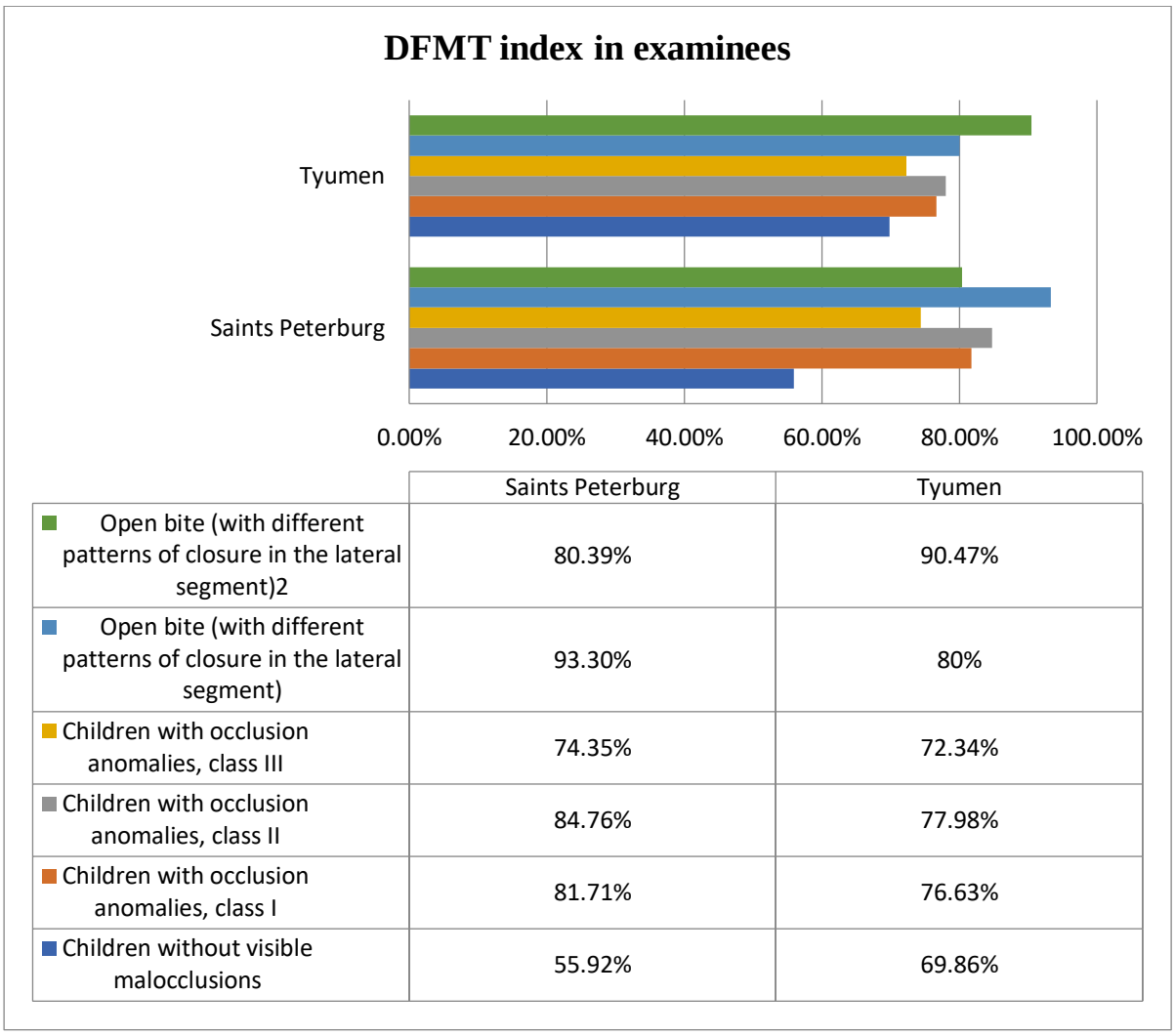
The number of children with a class I undergoing treatment was 17% in Tyumen and 33.17% in St. Petersburg. The situation with class II DFA is as follows: 23.5% (Tyumen) and 32.03% (St. Petersburg) with this pathology are treated by specialists. The situation is, however, different with class III anomalies – 53.19% (Tyumen) and 47%. (Saint Petersburg) [126].

Based on the data obtained, we were able to determine the average necessity of orthodontic treatment for children in these two regions. To achieve this, we used the following calculation: the sum of % of children from three groups who had not undergone orthotherapy. The calculation results were (66.83% + 67.97% + 53%) / 3 = 62.6% for St. Petersburg and (83% + 76.5% + 46.81%) = 68 .77% for Tyumen.

We then applied the ICON orthodontic index to the obtained data, and came up with the following values:

- an index coefficient of 34.27 among the examinees in Tyumen indicates a moderate degree of complexity of the malocclusion.

- an index coefficient of 31.34 among the examinees in St. Petersburg also indicates a moderate severity of anomalies in the region.

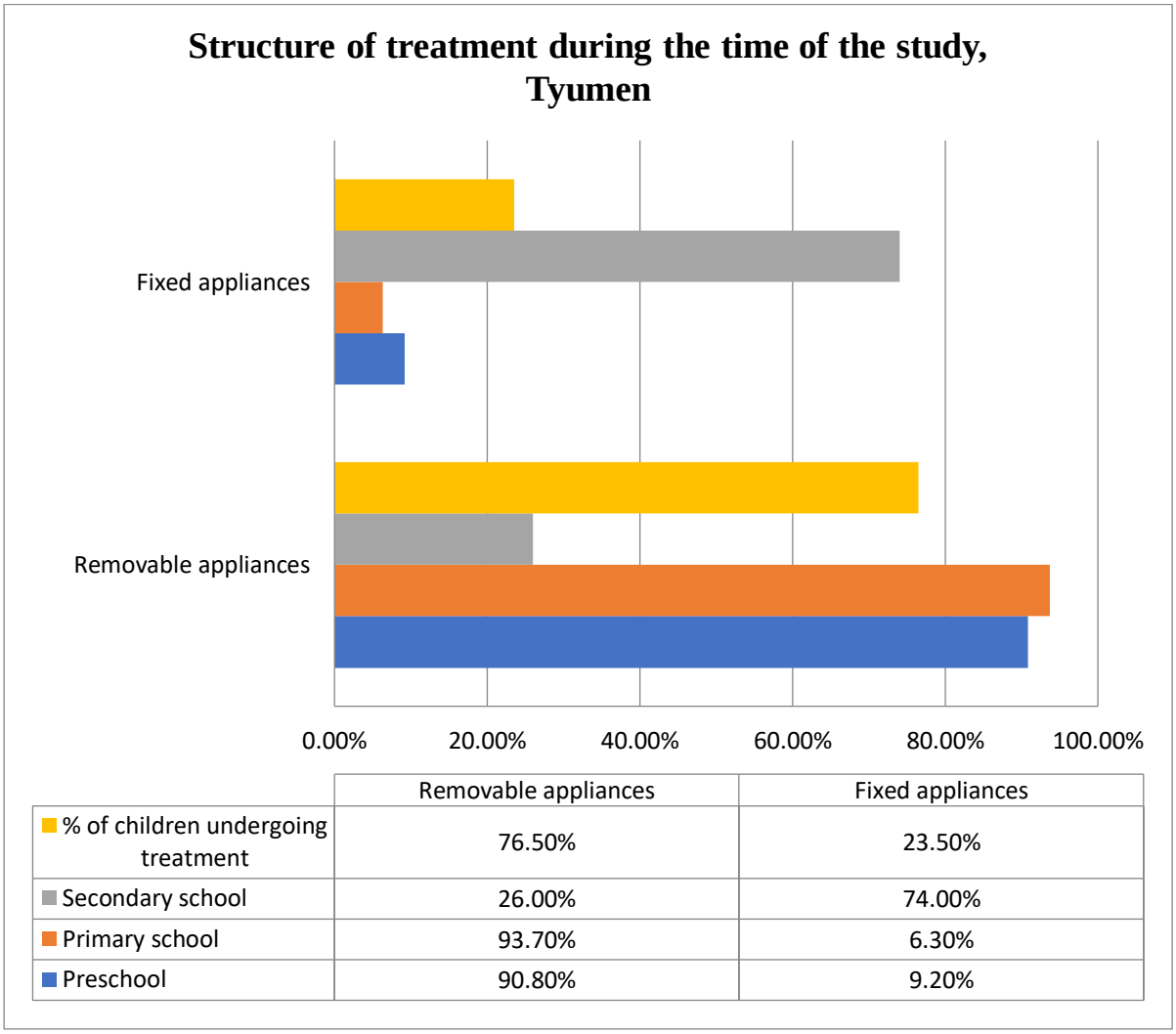


	Saints Peterburg	Tyumen
Open bite (with different patterns of closure in the lateral segment)2	80.39%	90.47%
Open bite (with different patterns of closure in the lateral segment)	93.30%	80%
Children with occlusion anomalies, class III	74.35%	72.34%
Children with occlusion anomalies, class II	84.76%	77.98%
Children with occlusion anomalies, class I	81.71%	76.63%
Children without visible malocclusions	55.92%	69.86%

Fig. 11. DFMT index in examinees

We also performed an analysis of the DFMT and the intensity of the carious process. Patients with crossbite had the highest prevalence (92% in Tyumen and 80.39% in St. Petersburg), which is characterized by improper formation of the food bolus and large amounts of food getting stuck in the interdental spaces; DFA was also highly prevalent in cases of open bite (80% and 93 .3% respectively). It is worth noting that most children with these pathologies also had disorders of the digestive tract and changes in taste sensitivity. Furthermore, a high incidence was observed in children with anomalies of individual teeth (76.63% and 81.71%). The localization of the carious process in these clinical situations was also important: for example, in patients with teeth positioning anomalies, the most common localization of carious cavities was on the contact surfaces of the teeth, especially in the area of the anomaly. Patients with an

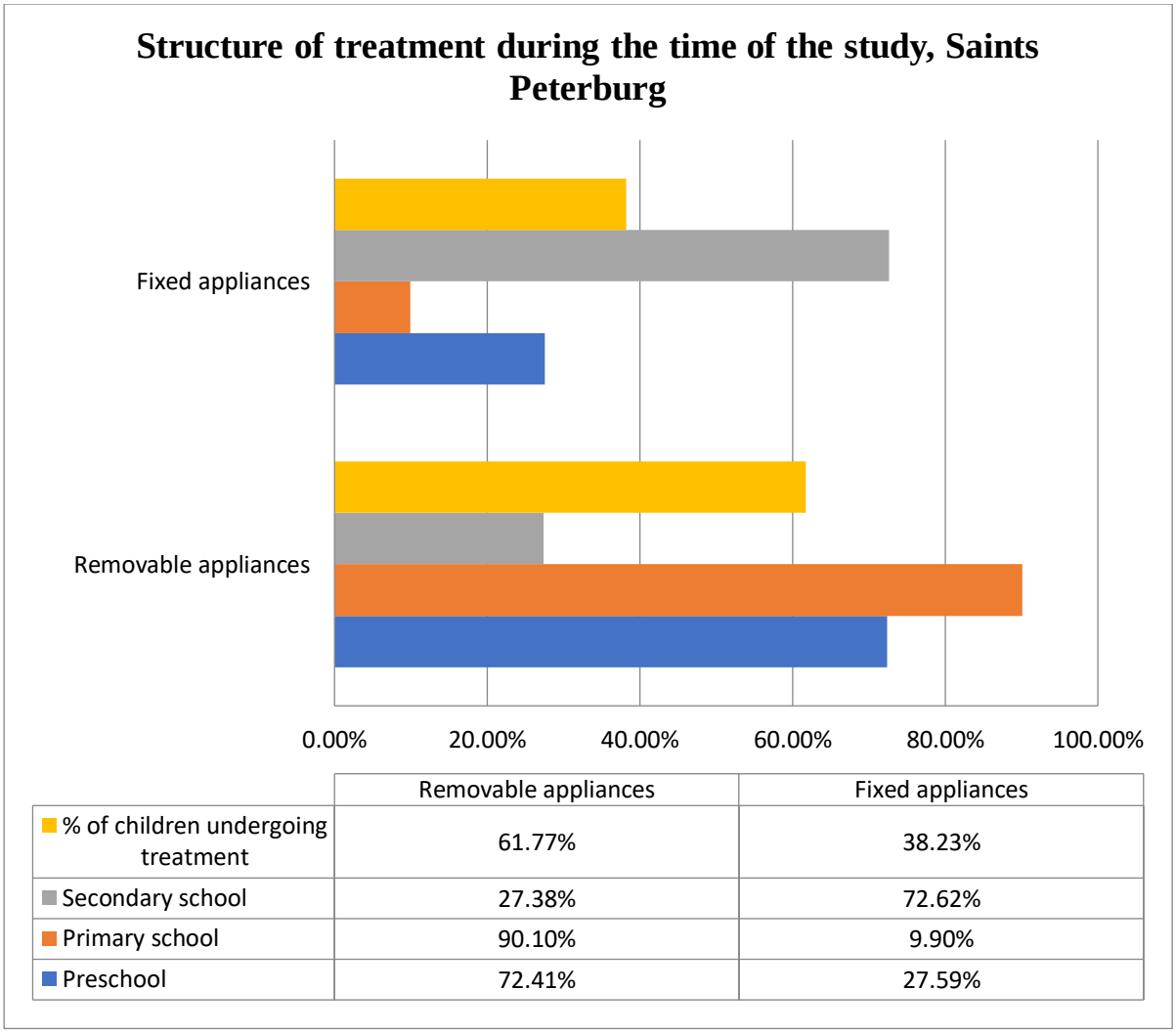
open bite were susceptible to caries on the chewing surfaces of the teeth, while a combined localization of caries in the area of the posterior cavity was prevalent in children with a crossbite. The highest values of the DFMT were typical for open and cross bites – 5.5 and 6.5 in Tyumen and 5.8 and 6.2 in St. Petersburg, respectively. We also compared the intensity and prevalence of caries among children with malocclusions and without their visible manifestations. The prevalence of caries was 69.85% in Tyumen and 55.92% in St. Petersburg in apparently healthy children, and in those cases the presence of carious cavities of different localization was noted. The DFMT values were 3.8 and 3.2, respectively, which indicates the relationship between DFA and the intensity and severity of the caries.



	Removable appliances	Fixed appliances
% of children undergoing treatment	76.50%	23.50%
Secondary school	26.00%	74.00%
Primary school	93.70%	6.30%
Preschool	90.80%	9.20%

Fig. 12. Structure of treatment during the time of the study, Tyumen

Considering the structure of treatment measures in studied regions we observed the following picture (Figure 12, Figure 13) – 90,8% (21) and 72.41% (21)of preschool children in Tyumen and St. Petersburg underwent DFA treatment which included removable orthodontic equipment of various action types. The remaining 9.2% (2) and 27.59% (8) were treated with the ‘2 by 4’ system, which is a fixed orthodontic appliance. The situation with the junior school group was similar – 93.7% (69) and 90.11% (82) were treated with removable appliances. In the middle school age group, we observed the emergence of various types of braces alongside therapeutic manipulations – 74% (23) in Tyumen and 72.62% (61) in St. Petersburg.



	Removable appliances	Fixed appliances
% of children undergoing treatment	61.77%	38.23%
Secondary school	27.38%	72.62%
Primary school	90.10%	9.90%
Preschool	72.41%	27.59%

Fig. 13. Structure of treatment during the time of the study, Saints Petersburg

The current outlook for both regions is identical, with the exception of the preschool and junior school groups in St. Petersburg (Figure 13)- 27.59% (8) of children

undergoing treatment on the ‘2 by 4’ brace system met certain problems with maintaining a place in the dentition due to improper eruption or untimely loss of teeth. However, this was leveled out by primary school age. In both regions, a large percentage of children were treated with fixed equipment (braces), which indicates both the favorable socio-economic background of said regions and the high degree of motivation of children for treatment. However, when comparing these groups with the bulk of the children examined, we found an extremely small number of children undergoing orthodontic treatment in both regions.

Summarizing this part of the study, we came to the following conclusion – the general picture of the distribution of anomalies is generally identical in the studied regions and correlates with the high prevalence of DFA both in Russia and in abroad, which is confirmed by the studied research literature (refer the ‘Prevalence of various forms of malocclusion’ paragraph). In this part of the work, etiological factors and the nature of their influence on the development of occlusion anomalies were described and analyzed [134].

3.2. Modern aspects of the malocclusion prophylaxis

Despite the development of modern clinical orthodontics, doctors often encounter an already formed malocclusion in a child during an outpatient appointment. This situations could to a degree be resolved by preventive measures aimed at the causes of the formation of DFA in children and adolescents [105].

From the perspective of modern dental science, domestic healthcare currently has a solid scientific basis which could be used to create relevant prophylaxis programs for dental diseases which meet the high level of international requirements. However, some aspects of their development and practical implementation do not always meet these requirements. The following key problems were identified:

- insufficient training of dentists to implement adequate prevention of DFA;
- lack of adequate number of dental hygienists;
- lack of close contact and mutual understanding between healthcare and education systems.

These problems create certain difficulties in the implementation of preventive measures. The treatment-oriented approach, formed by many years of planned rehabilitation of children and adults in the Russian Federation, still prevails in the minds of the majority of dentists, health care managers and the population itself, to a certain extent complicating the implementation of prophylaxis programs. According to the scientific research, a reduction in dental morbidity could only be achieved through the implementation of government-mediated prevention programs, which is confirmed both by international experience and the experience of our country.

The Russian Federation has positive experience in the development and implementation of scientifically based prevention programs for dental diseases. In recent years, scientific projects based on long-term and large-scale research have been introduced in Russia [201]. This is the school educational program for the prevention of dental diseases StAR-Procter and Gamble, conducted among children and adolescents from 1994 to 2006. There was also a comprehensive program for the prevention of dental diseases in children of the Volga region in Samara and the Republic of Tatarstan. Separately, it is worth mentioning the STAD prevention programs ‘Dazzling Smile for Life’ (in association with Colgate, 2009), and ‘Excellent Dental Health’ (also in association with Colgate, 2009). Social charity events were also carried out – an ‘Improvement’ comprehensive program of dental care for children without parental care [3].

These projects were implemented with a limited number of people involved and for a limited period of time using funds from manufacturing companies and charitable foundations. It is also worth noting that not a single program was aimed at preventing emergency situations associated with DFA.

On the territory of the Russian Federation, a mass, national dental examination aimed specifically at identifying people with existing malocclusions has not been carried out before – the existing samples from the author’s works are of a purely local nature or are aimed at finding the relationship between malocclusions and one or another pathology characteristic of the region. An analysis of literature sources was carried out, including those related to similar studies both on the territory of the Russian

Federation and in the former Soviet republics. Based on the data obtained, we can conclude that malocclusions in the Russian Federation are widespread, characterized by high frequency, and are mostly associated with general somatic diseases in childhood.

As of now there is no current program for the prevention of malocclusions in the Russian Federation (as in a number of other developed and developing countries) despite the huge percentage of their prevalence, the actual low coverage of the population with qualified orthodontic care and the shortage of medical personnel.

This can be explained by a number of reasons that emerge from the literature review:

- unpredictability of the appearance of DFA, even in the presence of concomitant and predisposing factors. As we can note, with a high risk of malocclusion, there will always be a certain number of children or adolescents in whom this nosological form of oral diseases may not occur;

- for full preventive work to combat certain occlusion anomalies, a comprehensive, global approach to the problem is necessary, which requires both the inclusion in the program of a large number of medical and support personnel – dentists, pediatricians, speech therapists, teachers, and mass examinations of all children and adolescents , with a full individual approach to each clinical case;

- with the possible implementation of the program in one form or another, one will have to face a number of economic and social factors: the high cost and expense of many preventive measures, which will often be impossible to cover from the state health budget, the impossibility of full prevention in families with disadvantaged socio-economic status, the difficulty of implementing this program in remote and sparsely populated areas and regions where there is a shortage of medical personnel, there is also the problem of finding an individual approach to the child, which would be impossible with mass prevention;

- the problem arises of the need for mass preventive work with the population, primarily with young people and families with children. Activities in this area should include lectures at schools, universities, educational materials and lessons at family planning and child health centers, etc.

As stated earlier in the literature review, the most pronounced picture of DFA in children of preschool and early school age is observed as a result of the influence of the following factors – mouth breathing, bad habits and dysfunction or parafunction of the tongue. These predisposing factors are extremely interesting from the point of view of both joint work with related specialists, which increases the controllability of the results of preventive measures and includes preventive techniques in several areas, and in terms of accumulating the evidence base on the etiology and pathogenesis of occlusion anomalies and the above-mentioned general somatic diseases.

A future program for the prevention of DFA in children of preschool and early school age should solve the following tasks:

-correction of bad habits (sucking objects, incorrect posture, hyper\hypofunction of the tongue)

-relieving the child of mouth breathing and sleep apnea

- normalization of diet (abundance of solid, rough food).

Elimination of bad habits is the primary goal in the prevention of DFA according to a number of authors [189, 204, 265, 180]. However, after analyzing a number of literary sources, we can come to the conclusion that the authors disagree on ways to correct them. Researchers share a common point of view in prescribing a set of therapeutic and preventive exercises to normalize the work of facial and masticatory muscles, the position of the lower jaw, working with the muscles of the upper shoulder girdle, and general recommendations for eliminating bad oral habits.

It is important, first of all, to train parents in methods of combating bad habits in children, and, if necessary, help with the choice of corrective therapy.

A number of authors propose natural feeding as the primary method of preventing DFA [142, 245], and if certain bad habits arise, they offer a number of functional therapy methods:

1.Myotherapy.

2.Functional re-education.

3. Parental control of bad habits.

Let's look at each of these points in more detail.

1. Myotherapy includes not only a set of exercises and practices for the development and maintenance of muscle tone in the maxillofacial area, but also the entire body as a whole. In the literature review of this work, it was said that the orofascial muscles (including the tongue) are involved in a huge number of vital processes – breathing, speech, chewing and swallowing a bolus of food. Also, the correct and harmonious development of the muscles of the maxillofacial region plays an important role in the prevention and stabilization of the development of malocclusions. As a number of studies have shown [262, 166, 260, 240, 217], myotherapy, coupled with orthodontic treatment, leads to both a reduction in the active processes of formation of the occlusion and normalizes the functioning of organs, the dysfunction of which leads to the activation of the processes of formation of pathological occlusion – the work of the lingual muscle, respiratory organs, etc. As stated in the paragraph "Etiology and pathogenesis of malocclusions", malocclusions in children are often associated in one way or another with incorrect posture, so special attention should also be paid to it. For children with poor posture, a set of therapeutic physical exercises for the development of the muscles of the back and shoulder girdle, and therapeutic massage are recommended. Physical rehabilitation in this context has certain tasks that are closely related to the correction of the pathological process in DFA:

-creating the prerequisites for restoring the correct position of the body and shoulder girdle with the cervical and thoracic regions;

- stabilization of pathological processes associated with posture;

-formation and consolidation of the skill of correct posture;

-increasing the protective properties of the body.

2. Functional re-education

3. Parental control of the child's bad habits is the cornerstone of the prevention of malocclusions. Due to the fact that the child is often under the visual control of parents and close relatives, the responsibility for this point of prevention lies with them. First of all, this should include the correction of wearing a pacifier during the period after breastfeeding. Based on a number of studies, its use is permissible before the eruption of baby teeth. Also, the pacifier must be orthodontic: selected strictly according to the

shape and size of the child's dentition. Another bad habit, which also refers to the residual influence of breastfeeding, is sucking fingers and foreign objects – hard toys, pens, etc. These habits require mandatory correction, as they lead to a number of changes in both the functioning of the muscles of the maxilla and the structure of the bones of the upper and lower jaw, and an open bite is formed.

Based on the above data, we can draw the following conclusion that the future draft of the malocclusion prevention program must meet the following clear requirements:

- be comprehensive, if possible, cover the most vulnerable etiological factors from the point of view of the development of DFA, especially those related to the general somatic health of the child

-the program should intensify cooperation between clinical doctors and specialists in different fields – general dentists, orthodontists, otolaryngologists, neurologists, speech therapists, etc.

- the program should include promotion of oral health in general, should explain to parents and children the connection between functional occlusion and general somatic health,

-covering only and not so much the activities of doctors, but to help the parents and relatives of the child avoid the development and worsening of malocclusion pathology.

An analysis of domestic and foreign medical literature suggests the absence of a malocclusion prevention program as such. Foreign prevention programs are mainly aimed at preventing caries complications, the outcome of which is adentia of temporary and permanent teeth, which in turn can lead to orthodontic pathology. As such, there is no documented program for the prevention of bad habits and general somatic diseases, tied specifically to solving problems in orthodontics.

Bearing in mind the lack of a program for the prevention of occlusion in the Russian Federation, the high level of their prevalence, as well as the predisposition in childhood to factors that activate occlusion pathologies, we come to the conclusion that it is necessary to create a comprehensive program for the prevention of malocclusion in

children and adolescents, aimed not only at preventive elimination of DFA, but also associated pathological factors.

3.3. Results of assessing the malocclusion incidence and the necessity for orthodontic treatment using the ICON index

During clinical dental examinations, the examinees' malocclusion status was assessed using the ICON indexing method (refer 'Materials and methods' chapter).

In all examined groups of children, there were approximately the same number of boys and girls, so gender was also not a considerable factor during the. Furthermore, due to the nature of the study, i.e. a continuous, population-based character, the emphasis in was on determining the severity of the clinical situation in the entire population as a whole.

The research material is highly representative due to the involvement of large groups of respondents in the study.

The results of evaluating the DFA incidence in both regions were reported earlier at values to 56.8% in Tyumen and 63.82% in St. Petersburg. According to the data obtained, the most widespread in both regions are anomalies associated with Angle class I and all class II anomalies [133].

Table 6. Anamnesis data in patients with malocclusions

	Qty	**Percentage**
Complaints of the patient at the time of examination, their characteristics	99	82,5
History of the present disease (onset, causes, disease development, dynamics)	102	85,0
Anamnesis of the development of the dentofacial system	52	43,3
The presence of bad habits	32	26,7
Past and concomitant diseases (ENT, endocrine diseases, etc.)	65	54,2
Heredity	107	89,2
Previous orthodontic treatment, if applicable	96	80,0

Anamnesis is an important part of planning orthodontic treatment, since it is necessary to exclude and work with with exo- or endogenous factors in a number of

conditions prior to the treatment itself. Therefore, during the survey of orthodontists, a question was asked regarding the collection of anamnesis and information about the possible causes of DFA. As our results suggest, orthodontists are less likely to be interested in the patient's bad habits (26.7%), stages of development of the child's dental system (43.3%) and past diseases of other organs and systems (54.2%). This is mostly due to the external manifestations of both bad habits (stooping, protrusion and open bite when sucking fingers) and general diseases (mouth breathing).

Table 7. Basic parameters when collecting anamnesis

	Always	**Sometimes**	**Barely/Never**	**Overall**
Chewing and facial muscles tonus	69,2%	18,3%	12,5%	100
Position, insertion and tonus of the lingual muscle	60%	24,2%	15,8%	100
Tonus and condition of the neck muscles	25,8%	28,3%	45,9%	100
Inspection and auscultation of the TMJ	46,2%	42,0%	11,8%	100
Tonus and condition of the shoulder girdle muscles (posture)	16,0%	42,8%	41,2%	100

The surveyed doctors revealed that they mostly pay attention to the tonus of the masticatory muscles (69.25%) and the position of the tongue with the frenulum (60%) during the examinations and collecting an anamnesis. 25.8% of doctors were interested in the tone and condition of the neck muscles, and 16.0% were interested in the condition of the shoulder girdle. On the one hand, these data may indicate different causes of DFA in a particular case in a doctor's medical practice, on the other hand, they may indicate different clinical ideas about the causes of the formation of occlusion anomalies.

The first parameter assessed in the ICON index is the aesthetic component. The methodology for its determination and calculation is described in the 'Clinical research methods' paragraph.

The aesthetic component of the ICON index was calculated as follows: first, an individual calculation using a photo scale was performed for each child, then the results were summarized by age group. Knowing the methodology for calculating each component of the index, it is possible to isolate its average population value for each region under study using the following formula:

$$(\sum x + y + z) \div Nt \div R,$$

where x+y+z is the sum of the obtained indicators for three age groups,

Nt – number of respondents participating in the study,

R – coefficient individual for each index component.

For the aesthetic component of Tyumen, we came up with the following result:

$12691 \div 549 \div 7 = 3{,}30$

which corresponds to point 3 of the ICON index aesthetic component. Using the same formula, we were able to determine the remaining points, thereby showing the average result in the population under study.

The next component is the identification of crowding and abnormalities of individual teeth.

Anomalies in the individual teeth positioning in the studied sample of respondents were one of the most common pathologies – for example, this type of anomaly in various forms occurs in 78.14% of children, and in 38.98% of cases it is an only anomaly in the Tyumen study group. In St. Petersburg, the picture of the distribution of anomalies of individual teeth is as follows – the DFA was noted in 66.08% of children, and was the only anomaly present in 30.27% of respondents. The prevalence of this dental anomaly varies drastically in differently aged groups. Considering the selected selection of respondents, we noted an increase in the prevalence of this anomaly by primary school age in both regions and a slight decrease by middle school age. There are several theories of the occurrence of crowding of teeth, the most relevant of which is the theory of Bjork (1960), who saw the cause of dental anomalies in the tendency of the lower jaw to rotate movements. This theory has been confirmed by a number of researchers – Parera, Vaden, etc. It has been proven that anterior rotation of the mandible by 4° significantly increases the risk of this type of

anomaly. There are also numerous theories investigating the influence of muscle imbalance on the physiological location of teeth in the arch.

Crossbite is the next component of the ICON index. The incidence of this anomaly was 7.65% (42) (Tyumen) and 8.82% (51) (St. Petersburg) percent (Figure 7, Figure 8, Figure 9), and similar to the cases of anomalies in teeth positioning, there was an age-related dimorphism, increase in frequency at primary school age and decrease in secondary school age. These results could be explained by the factor of skeletal growth of the upper and lower jaws since the prevalence of crossbite often decreases in children after 10–12 years of age [157]. Often, the etiology of the pathogenesis of crossbite is associated with the early loss of permanent teeth, a violation of the timing of their eruption, or the child's habit of chewing food on one side of the dentition. A number of researchers note the connection between transversal malocclusions (including cross bites) and disorders of the musculoskeletal system – scoliosis and systemic lesions of the entire skeleton. During the clinical examination of children, we noted all types of cross occlusion – palatino-occlusion, linguo-occlusion, vestibulo-occlusion, as well as their combinations. Clinically, this type of pathology is expressed in a violation of the tubercular contact of the antagonist teeth. For example, it was noted that in children with palatinoocclusion, the palatal cusps of the maxillary molars do not contact the longitudinal fissures of the antagonist teeth, but with their lingual lingual cusps.

The next component of the ICON index is two DFA forms at once – open and deep bite. Deep bite is closely related to Angle class II malocclusions, which in the group of children considered are the second most common after anomalies of individual teeth. The propagation of this pathology is as follows: the prevalence of all types of class II anomalies – that is, independent and combined forms – is 48.82% and 44.29% (Tyumen and St. Petersburg). The most common cause of these forms of DFA is a violation of the skeletal growth of one of the jaws. In the considered sample of children, in many cases, the factor in the development of pathology is either excessive growth of the upper jaw with the physiological size of the lower jaw, or underdevelopment of the lower jaw with normal development of the upper jaw. The reason for this may be many factors, both pre- and postnatal. The clinical picture of concomitant pathology is added

to the general background characteristic of class II anomalies. For example, in children with combined crossbite, increased wear of hard dental tissues on the opposite side and chronic pain in the TMJ were noted. However, in children with an independent form of class II pathology, complicated cases of the disease were observed – dysfunction of breathing and swallowing, which is expressed in diseases of the respiratory tract and nasopharynx. Often, all forms of class II pathology can be corrected with hardware in childhood; after the growth of the jaw bones is completed, this problem is solved in a more complex manner, often using surgical techniques and taking longer.

The structure of malocclusion of Angle class II is presented in detail below.

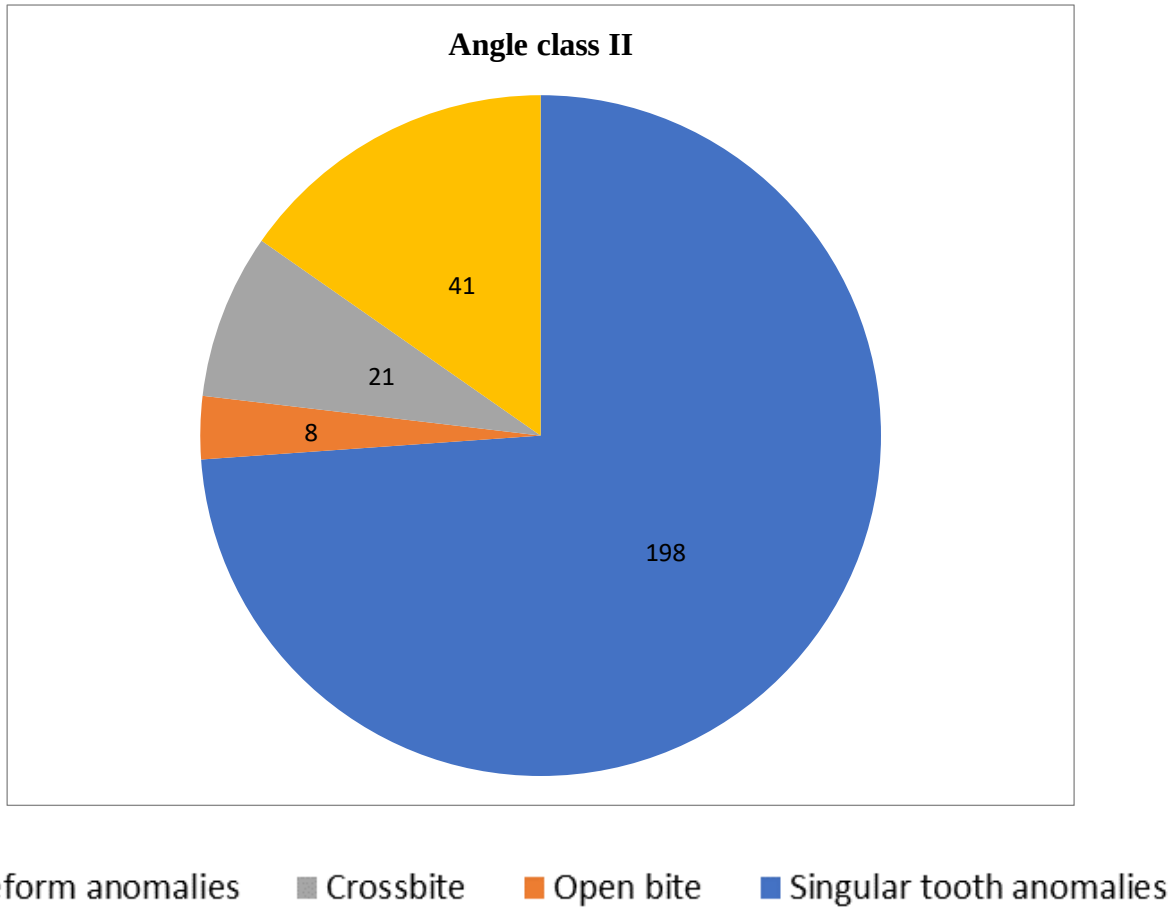


Fig. 14. Distribution of dental anomalies of Angle II class in Tyumen

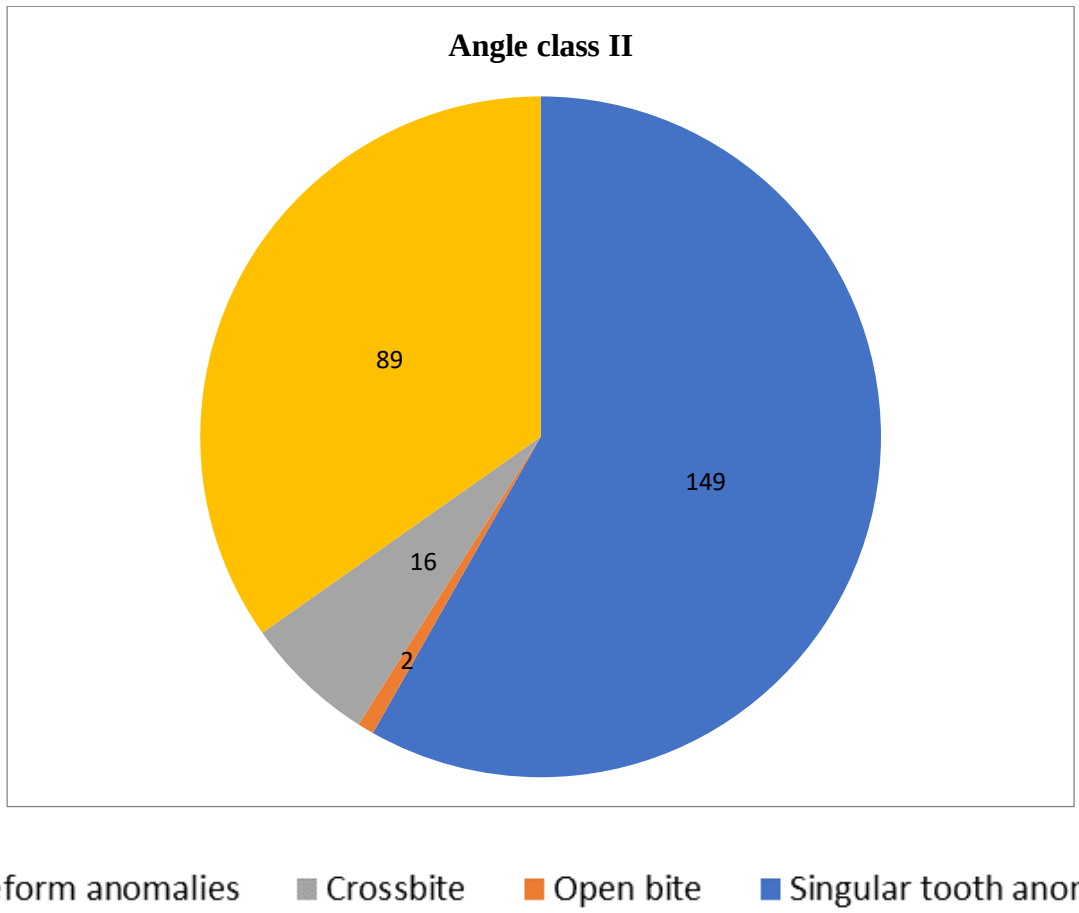


Fig. 15. Distribution of dental anomalies of
Angle II class in Saints Petersburg

Based on the obtained data, it is clear that the anomaly does not tend to decrease during middle school age, as was the case with other occlusion pathologies. This can be explained by the fact that with the growth of the skull bones, the severity of this DFA worsens. This trend is especially clearly visible in the example of inspections in the city of St. Petersburg. Thus, among those suffering from this pathology there are 13.33% of preschoolers, while those from older age groups are already 40% and 46.67%, respectively. Open bite is a complex form of DFA, both in its etiology and pathogenesis, and in terms of treatment methods. There are two main forms of open bite – true (rachitic) which is more often called vertical incisal disocclusion and false (traumatic). The clinical picture of these pathologies is different and in fact they are independent bite pathologies.

The last component of the ICON index is the fissure-tubercle ratio. Based on the indexing methodology, there are three options:

- fissure-tubercle (I, II and III class);

- any other state not including tubercular;
- tubercular.

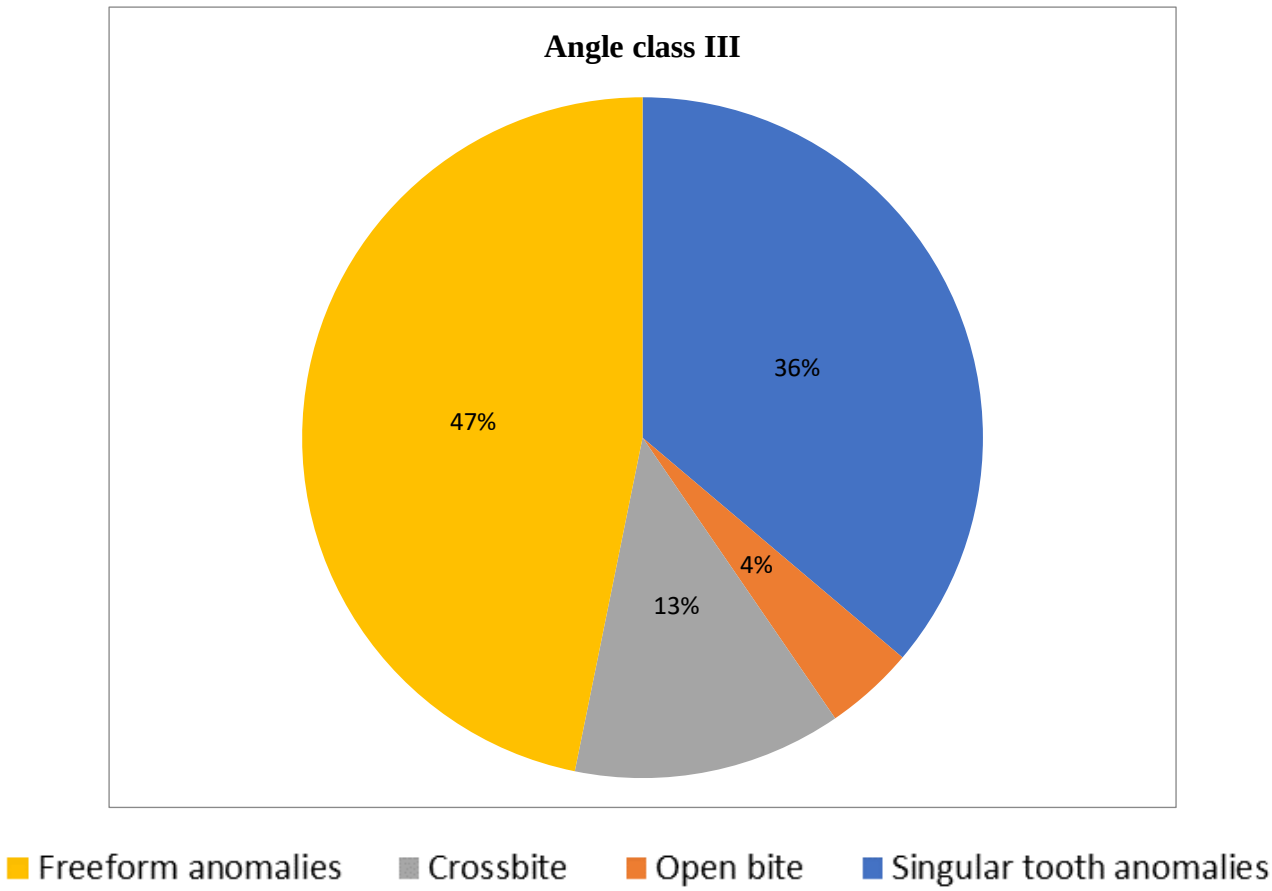


Fig. 16. Distribution of dental anomalies
Angle III class in Tyumen

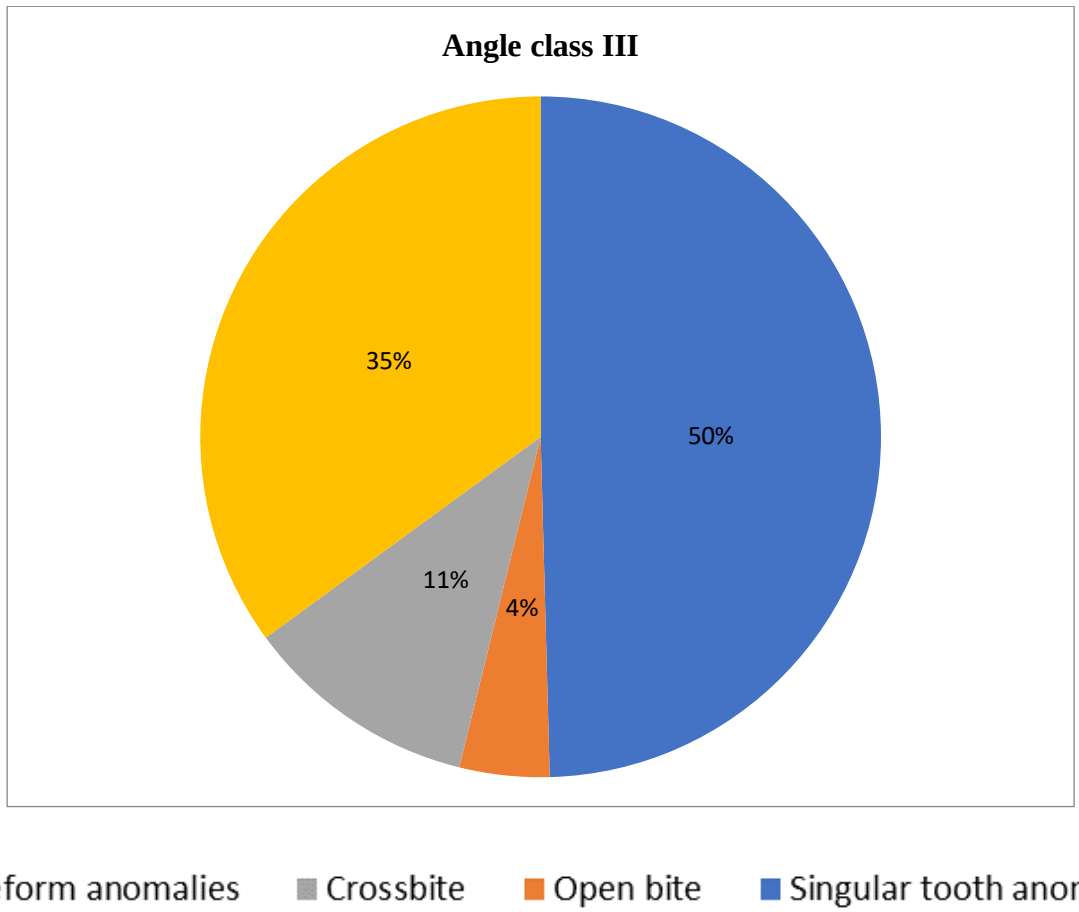


Fig. 17. Distribution of dental anomalies
Angle III class in Saints Petersburg

The physiological fissure-tubercle relationship of the jaws is often observed in individuals with uncombined forms of occlusion according to Engle's class I, II, III. Any form of relationship that does not include tubercle can include clinical situations when a particular tooth or segment is located outside the dental arch – with anomalies in the position of the teeth, crossbite or vertical incisal disocclusion. Direct tubercular contact is most common among anomalies according to Engle's III class – the cutting edges of the antagonist teeth are in end-to-end contact with each other, while fissure-tubercular contact is noted in the area of the molars.

3.4. Analysis of the stages of the experimental part of the study

Epidemiological studies of malocclusion anomalies are the most informative for assessing the population's need for orthodontic treatment and evaluating the level of prevention in a specific region. This research method allows for the examination of a

large number of respondents and enables the assessment of the prevalence of specific forms of pathology at a local or population level.

This methodology was applied during the study of groups of children of three different age groups in two cities.

In order to study the prevalence of malocclusion anomalies among children aged 6-14, a comprehensive epidemiological survey of preschool and school children in Tyumen and St. Petersburg was conducted. The number and age composition of the examined population are reflected in Table 1.

The total number of children examined was 967 (Tyumen) and 907 children (Saints Petersburg).

The presented research material is characterized by a high representativeness of the current situation, as a representative number of students is included in the examined age groups.

To study the prevalence of malocclusion anomalies in 2018, comprehensive epidemiological research was conducted on children and adolescents aged 6-14 in the city of Tyumen. The number and age composition of the study population are reflected in Table 8.

Table 8. Results of children's examinations in Tyumen

Age group	Age (years)	Number of patients	Number of detected malocclusion anomalies	%, (95% CI)
Preschool	6	109	85	78,0% (69,0%–85,4%)
Primary school	7	115	94	81,7% (73,5%–88,3%)
	8	101	84	83,2% (74,4%–89,9%)
	9	96	63	65,6% (55,2%–75,0%)
	10	105	47	44,8% (35,0%–54,8%)
Secondary school	11	116	51	44,0% (34,8%–53,5%)
	12	93	41	44,1% (33,8%–54,8%)
	13	134	45	33,6% (25,7%–42,2%)
	14	98	39	39,8% (30%–50,2%)
	Total	967	549	56,8% (53,6%–59,9%)

Based on the research data, we can see that the prevalence rate is consistent among all groups of children and does not depend on the child's place of birth. Additionally, we observe that the prevalence rate of anomalies aligns with global and national trends, at 56.8%, indicating a high level of prevalence.

As it has been established, the prevalence rate of DFA is equally high among children in both Tyumen and St. Petersburg. This may indicate a consistently high level of prevalence not only within the region but also across Russia as a whole. According to the obtained data, the highest prevalence rates of malocclusion anomalies were observed in the preschool and early school-age groups, indicating a compensatory decrease in DFA during the final period of permanent occlusion formation in this population.

Data on the nosological forms of anomalies that dominate in the presented region are of great importance to orthodontic clinicians. These data are presented in Table 6. It includes information on both malocclusion anomalies and their combined forms with anomalies of individual teeth and jaw segments.

It has been established that the most common anomalies in tooth position in the examined sample of children are found in the Class I Angle’s classification, accounting for 38.9%. Overall, DFA associated with this skeletal class constitutes 42.6% (including traumatic open bite and crossbite). Class II anomalies make up 48.8% of the total occlusal pathology, and the number of tooth anomalies in this jaw relationship is also high at 36%.

Studying the nosological forms of malocclusion anomalies is also of interest for consideration.

Thus, we can observe a significant number of respondents with anomalies in the position of individual teeth and anomalies associated with Class II malocclusion. This pattern aligns with the overall trend of DFA prevalence discussed in the first chapter of this study.

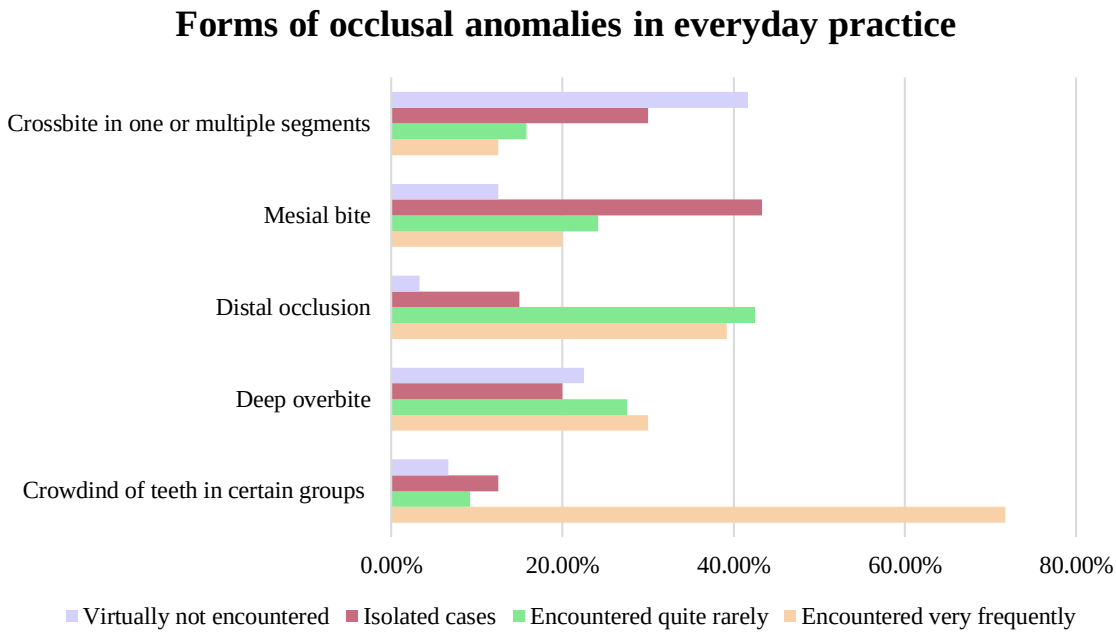


Fig. 18. Forms of malocclusion anomalies in everyday practice

It is also worth noting the trend identified during the survey of orthodontic doctors. The doctors were asked a series of questions regarding the prevalence of various forms of occlusal anomalies, their severity, examination algorithms for patients, and medical documentation practices. Based on the analysis of the responses obtained, we observe the following picture of the prevalence of occlusal anomalies according to the clinical observations of practising doctors (Figure 18). Doctors most commonly encounter crowding of teeth in various groups (71.7%), followed by distal occlusion (39.2%), and less frequently, deep bite (30%). Crossbite and mesial bite are reported to be less common than other anomalies by the majority of clinicians (12.5% and 20% respectively). These findings align with the statistical information presented and described in the section "Prevalence of various forms of malocclusion anomalies."

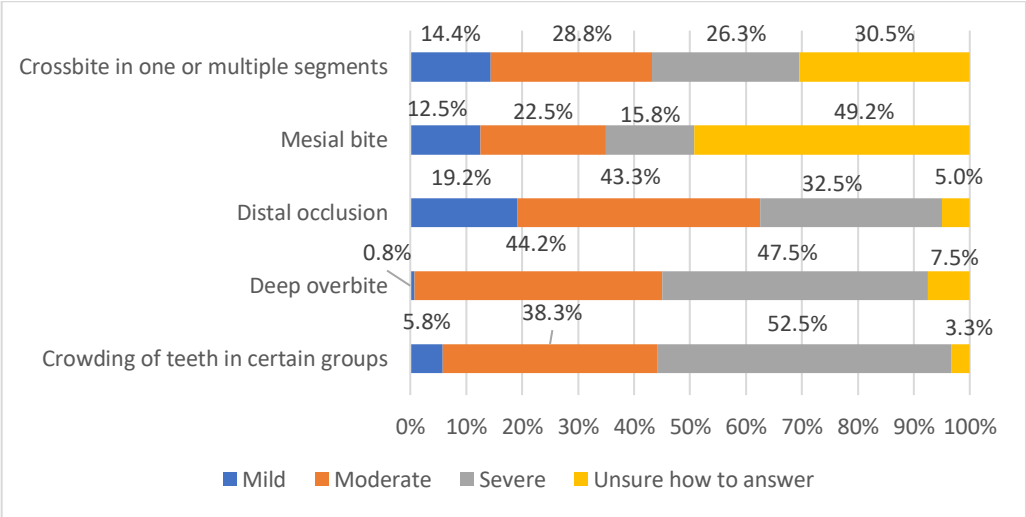


Fig. 19. Severity of individual pathologies in medical practice, %

During discussions with doctors regarding the severity of encountered occlusal anomalies (Figure 19), the surveyed professionals noted the most severe clinical situation in patients with crowding of individual teeth (52.5%), which in some cases requires tooth extraction (premolars, molars) and the use of skeletal anchorage for distalization [182].

A severe situation with deep overbite is noted by 47.5% of respondents, while distal occlusion is observed in 32.5% of cases. Doctors encountered complex forms of mesial occlusion in 15.8% of cases. Severe skeletal forms of such occlusal anomalies require not only orthodontic treatment but often also orthognathic surgery if indicated, and in many situations, they need to be treated in stages, starting with removable functional appliances and then progressing to fixed appliances. 26.3% of clinicians noted severe forms of crossbite in their patients.

Table 9. Prevalence of dental caries among examined children (Tyumen)

	The entire population under study	**Prevalence of caries in percentages**
Children without visible DFA	418	292 (69,86%±3,1)
Anomalies of individual teeth of Class I	214	164 (77%±4,21)
Anomalies of Class II (including combined forms)	268	209 (78%±5,38)
Anomalies of Class III (including combined forms)	47	34 (72%±4,11)
Open bite (true and traumatic forms)	15	12 (83%±4,02)
Crossbite	42	38 (92%±4,37)

It is worth noting here the prevalence of dental caries among healthy children and children with occlusal anomalies (Table 9). As follows from the presented data, children without occlusal anomalies suffer from caries less (69.86% ± 3.1) than children with CFA. The highest prevalence of the carious process is typical for children with crossbite (92% ± 4.37). We can see a similar picture by analyzing the picture of the state of the oral cavity taking into account the DMF index (Table 10).

Table 10. The intensity of caries in examined children and the DMF index (Tyumen city)

Types of malocclusion anomalies	The entire population under examination	DMF
Children without visible DFA	418	3,8
Class I anomalies of individual teeth	214	4,6
Class II anomalies	268	5,2
Class III anomalies	47	4,9
Open bite	15	5,5
Crossbite	42	6,5

Below is the age and gender structure of the examined individuals.

From the total number of participants (967 schoolchildren), a group of 549 individuals with malocclusion anomalies was selected. Within this group, the ICON index of treatment need was applied during the examination (Table 11).

Table 11. Analysis of malocclusion pathologies in patients (Tyumen city) using the ICON index

Component of ICON index	Age group		
	Preschool group	Elementary school group	Middle school group
	85 children	288 children	176 children
Aesthetic component	2233	6566	3892
Crowding in the upper jaw / Gaps between teeth	480	1355	805
Crossbite	45	110	55
Open bite	408	728	280
Fissure-cusp contact	246	588	288
Calculation result	3412/85=40,14	9347/288=32,45	5320/176=30,23
Arithmetic mean for three groups	34,27		

Table 11 presents the final calculated coefficients for each component, the final figures are obtained by adding the components using the ICON formula and dividing by the number of patients examined. The result for Tyumen is 34.27, which indicates a moderate severity of malocclusions.

At the time of the study, 128 children were undergoing orthodontic treatment (removable and fixed appliances). The highest proportion of children undergoing treatment was observed in the preschool and elementary school age groups – 27% and 25%, respectively, while in the middle school group, only 17% of children with DFA were receiving orthodontic treatment (Figure 12, Figure 13). The treatment complex structure among the examined children was represented by the following types: removable appliance treatment (with single and twin block appliances), 2/4 bracket system for children with mixed dentition, and classical fixed technique (ligature and self-ligating bracket systems). From the collected data, it can be concluded that 76.5%

of children underwent treatment with removable appliances, while 23.5% of the examined children had a bracket system.

Table 12. Types of orthodontic appliances (%)

Appliances	Qty	Percent
Single-jaw mechanical appliances	85	70,8
Twin-block functional appliances	73	60,8
Appliances with combined action	36	30,0
Extraoral appliances	11	9,2
LM-activators and trainers	13	10,8

As we can see from the survey results (appendix A), removable mechanical functional appliances remain one of the main methods for correcting occlusal anomalies, with 70.8% and 60.8% of respondents using them in their clinical practice (Table 12). Extraoral appliances, due to their bulkiness and patient discomfort, are used less frequently – 9.2%, while trainers are slightly more commonly used – 10.8%. Despite the rapid development of fixed techniques, wearing removable appliances remains an important stage in correcting occlusal anomalies in mixed dentition. Even in cases where further treatment of the child involves the use of a bracket system, the treatment dynamics are simplified, and achieving good results is usually accomplished in a shorter period [201, 216].

Table 13. Degree of application of various types of fixed orthodontic treatment

Types of fixed orthodontic appliances	Qty	Percent
Classical ligature bracket systems	96	80,0
Self-ligating bracket systems (active and passive)	85	70,8
Partial bracket systems	29	24,2
Fixed appliances of mechanical action (such as the Marko Rosa appliance, etc.)	36	30,0
Fixed functional appliances (such as the Herbst appliance, etc.)	9	7,5

The main method of treating malocclusion anomalies remains non-removable techniques for bite correction (Table 13). Therefore, it is not surprising that respondents have a high level of utilization of various types of bracket systems (80%, 70.8%, and 24.2%). The utilization of non-removable appliances with mechanical and functional action is lower (30% and 7.5%). Non-removable appliances are traditionally used less frequently than removable ones [148] due to various reasons: high manufacturing costs, preparation of supporting teeth for bonding rings, complicated oral hygiene and cleansing of the appliance's space, and many others.

Table 14. Results of examinations of children in St. Petersburg

Age group	Age	Number of patients	Number of anomalies	%, (95% CI)
Preschool	6	93	79	84,94% (78,62%–91,26%)
Primary school	7	98	69	70,41% (64,09%–76,73%)
	8	97	81	83,5% (77,18%–89,82%)
	9	93	78	83,87% (77,55%–90,19%)
	10	95	53	55,78% (49,46%–62,1%)
Secondary school	11	106	59	52,29% (45,97%–58,61)
	12	109	57	52,3% (45,98%–58,62%)
	13	112	56	50% (43,68%–56,32%)
	14	104	46	44,23% (37,91%–50,55
	Total	907	578	63,72% (57,4%–70,04%)

The highest prevalence of DFA was also observed in the preschool and early school-age (young schoolchildren) groups. However, here we observe a smoother decrease in the prevalence of anomalies in the middle school-age group, in contrast to the Tyumen group, where this transition was more abrupt.

It is also worth noting that in this region, based on the obtained data, anomalies associated with Class II (Angle’s classification) malocclusion prevail – 44.3%. In addition, a significant portion consists of children with Class III jaw relationship – 20.2% (compared to 8.56% in the city of Tyumen). On the contrary, the number of children with anomalies associated with Class I is significantly lower – 35%.

Special attention was given to the examinations of children undergoing orthodontic treatment. In this region, the percentage of different age groups undergoing treatment is approximately equal – 36%, 32%, and 38% respectively. The proportion of children undergoing removable appliance treatment is 61%, while bracket systems were used for 39% of the examined children.

The obtained data indicate a high prevalence of the studied pathology across all regions, as well as a high variability of DFA, which necessitates an increase in the volume, quality, and accessibility of orthodontic care provided.

The structure and nature of malocclusion anomalies play a significant role in the planning of preventive measures and recommendations for further treatment. Of particular importance is the nosological form of the anomaly – individual teeth and tooth groups in a neutral bite, or malocclusion anomalies directly.

The obtained data confirm the high prevalence of anomalies both in individual teeth and in the overall occlusion. This indicates the need to increase preventive measures among children and teenagers.

Based on the research data, we can see that the frequency of prevalence is the same among all groups of children and does not depend on the child's place of birth. We also observe that the frequency of anomaly prevalence aligns with global and national trends – 56.8%, indicating a high level of prevalence.

The structure and nature of DFA play a significant role in planning preventive measures and recommendations for further treatment. The nosological form of the anomaly, specifically individual teeth and tooth groups in a neutral bite, or malocclusion anomalies directly, holds particular importance.

The obtained data indicate a high degree of prevalence of anomalies, both in individual teeth and in the overall occlusion. This necessitates an increase in preventive measures among children and adolescents.

Table 15. Prevalence of dental caries among examined children (Saint Petersburg)

Types of anomalies in patients	Entire population considered	Prevalence of dental caries in percentages
Children without visible DFA	329	55,92%±5,75
Anomalies of individual teeth, Class I	175	81,71%±5,81
Anomalies of Class II (including combined forms)	256	84,76%±5,23
Anomalies of Class III (including combined forms)	117	74,35%±4,21
Open bite (true and traumatic forms)	15	93,3%±4,03
Crossbite	51	80,39%±6,21

The study revealed the prevalence of dental caries among healthy children and children with anomalies of occlusion (Table 15) in St. Petersburg. The data obtained showed that children without occlusal anomalies suffer from caries less (55.92% ± 5.75) than children with PCA. The highest prevalence of the carious process is typical for children with open bite (93.3%±4.03). Crossbite, in contrast to Tyumen, is represented by lower rates (80.39% ± 6.21 – St. Petersburg, 92% ± 4.37 – Tyumen). We can see an identical picture by analyzing the picture of the state of the oral cavity taking into account the PCI index (Table 16). The situation with the caries process in children in Tyumen and St. Petersburg is almost identical, due to the high prevalence of CFA as a factor in the development of disease of the hard tissues of teeth.

Table 16. Caries intensity among examined children considering DMFT index (Saint Petersburg)

Types of anomalies in patients	Entire population considered	DFMT
Children without visible DFA	329	3,2
Anomalies of individual teeth, Class I	175	5,1
Anomalies of Class II	256	5,3
Anomalies of Class III	117	5,1
Open bite	15	5,8
Crossbite	51	6,2

From the total number of participants (907 schoolchildren), a group of 578 individuals with malocclusion anomalies was selected. Within this group, the ICON index of treatment need was applied during the examination.

Table 17. Analysis of malocclusion pathologies in patients from Saint Petersburg using the ICON index

Component of ICON index	Age group		
	Preschool group	Elementary school group	Middle school group
	79 children	281 children	218 children
Aesthetic component	2095	5991	3569
Crowding in the upper jaw / Gaps between teeth	395	1245	932
Crossbite	41	101	49
Open bite	398	546	234
Fissure-cusp contact	305	487	296
Calculation result	3234/79=40,94	8370/281=29,78	5080/218= 23,30
Arithmetic mean for three groups	31,34		

Table 17 presents the final estimated coefficients for each component, the final figures being obtained by adding the components using the ICON formula and dividing by the number of patients examined. As a result, in St. Petersburg, the final result of the study was 31.34, which indicates a moderate severity of DFA.

3.5. Criteria for selecting orthodontic treatment methods in the studied group

During the collection of statistical data and information on the prevalence of malocclusion anomalies among the examined patients, we divided the respondents into two equal groups in terms of the number of individuals and the quality of anomalies: control and experimental groups.

In the control group, a standard set of orthodontic manipulations was applied and implemented, including examination, diagnosis, application of appliance methods (according to age indications), and non-removable techniques.

In the experimental group, we followed a different protocol: examination, diagnosis, referral or consultative appointment with related specialists such as a paediatrician, otolaryngologist, speech therapist, or manual therapist. We applied myofunctional appliances during the temporary dentition stage, removable appliances, and a partial bracket system with a gradual transition to a full non-removable technique.

The rationale for involving related specialists is presented in the section titled "Modern Methods of Treatment and Prevention of Malocclusion Anomalies." The main criteria during patient examination were existing or previously present nasal breathing disorders, swallowing problems, shortened frenulum or speech development issues, pronounced postural problems or tendencies towards such problems. The engagement of a paediatrician is deemed necessary to us for several reasons: the development of a well-balanced diet plan for the child, including an abundance of solid and firm food, as well as the assessment of the child's vitamin D levels in the body.

As we discovered in the second chapter of this study, the difference between sunny days and the corresponding dose of sunlight in the cities of St. Petersburg and Tyumen is not considered critical but falls below the levels observed in Southern regions of Russia. Consequently, due to the absence of geographical variations in the

prevalence of bite anomalies, we merged the two surveyed groups based on regions into one. A total of 1874 children were examined and evaluated. We included in our study only children with existing bite anomalies who were not undergoing orthodontic treatment, without considering their age or gender. The control group consisted of 121 children, while the experimental group included 118 children.

Table 18. Patient selection from the control and experimental groups before the study.

Patient selection from the control and experimental groups before the study				
Associated criteria of occlusal anomalies	**Experimental group**		**Control group**	
	(118)	**%**	**(121)**	**%**
Nocturnal apnea	26	22,0	32	26,4
Mouth breathing	19	16,1	24	19,8
Shortened frenula	31	26,3	33	27,3
Incorrect tongue position	38	32,2	41	33,9
Musculoskeletal disorders	58	49,1	64	52,8
Early extraction/loss of primary and permanent teeth	45	38,1	43	35,5
Disturbances in the timing of eruption of permanent teeth	58	45,1	61	50,4

First and foremost, during the initial examination and diagnosis, we sought to determine, through parent interviews or manual examination of the oral cavity, the nature and type of the child's breathing, the presence of nocturnal apnea, and chronic respiratory diseases. The parents of 43 children, in varying degrees, sought consultation from otolaryngologists regarding mouth breathing. Among them, 58 parents complained about their children experiencing nocturnal apnea.

The second criterion was the incorrect position of the tongue and the attachment of the mucous membrane frenula (tongue ties) [243]. During the examination, incorrect tongue position and, as a result, hyper- or hypotonia were identified in 79 children from the experimental sample. Shortening of the tongue frenula was found in 64 children regardless of the tone of the tongue muscles.

The third criterion was problems with the muscle tone of the shoulder girdle and postural anomalies, which are encountered to some extent in the majority of children

and adolescents. Among the selected individuals for the study, musculoskeletal disorders were observed in 122 children. Often, in preschool-age children, we observed emerging problems with the muscle tone of the spine, which manifest in harmful habits such as improper sitting posture at the table, leaning while sitting, and resting the hands on the chin. Meanwhile, in older children, we noted primarily flat deformities of the spine, such as kyphosis and scoliosis.

The fourth criterion was the timing of the eruption of primary and permanent teeth and their disturbances. Below is a table presenting the distribution of examined children with occlusal anomalies according to the criteria described above. It should be noted that in many cases, several criteria may coincide for certain patients.

Furthermore, we will provide a detailed breakdown of individual criteria and etiological factors, as well as their correlation with specific forms of occlusal pathology. We will emphasize the importance of considering these criteria when developing a comprehensive patient rehabilitation plan.

Table 19. The relationship between breathing anomalies and occlusal pathology in the control and experimental groups (people / %)*

Class of anomalies	**Subclass of anomalies**	**Mouth breathing 43**		**Nocturnal apnea 58**	
		E 19	**C 24**	**E 26**	**C 32**
Group of anomalies based on Class I occlusion	All anomalies	1 / 0,8	2 / 1,6	-	-
Group of anomalies based on Class II occlusion	Anomalies of Subclass 1	8 / 6,7	7 / 5,8	11 / 9,3	10 / 8.2
	Anomalies of Subclass 2	7 / 5,9	9 / 7,4	12 / 10,2	13 / 10,7
Group of anomalies based on Class III occlusion	All anomalies	3 / 2,5	6 / 4,9	3 / 2,5	9 / 7,4

*percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

First and foremost, it is important to mention the health and proper functioning of the respiratory system, specifically nasal breathing, the absence of which leads to a range of functional and morphological disorders in the maxillofacial area. The tone of the circular mouth muscles is disrupted, and negative pressure in the oral cavity is lost, clinically manifesting as sagging of the lower third of the face. Additionally, the tone of the chewing muscles is lost – this factor leads to the narrowing of the upper dental arch and a decrease in the volume of the maxillary sinuses. The child's face acquires distinct adenoid facial features. Functionally, mouth breathing, due to the physiological characteristics of the human respiratory system, does not allow for adequate oxygen supply to meet the body's needs. On the contrary, at some point, it leads to a decrease in lung capacity. From this perspective, a very indicative examination is the assessment of orthodontic patients with existing mouth breathing (A.R. Abliazov, N.P. Sysoev, L.P. Zubkova). The experiment involved conducting breathing tests (inhale/exhale) in patients with distal and mesial occlusion. The results of the study consistently demonstrated a decrease in respiratory parameters in patients with occlusal pathology. During the examination of children, we relied on parental interviews and objective data obtained during the examination, such as assessing the nature of breathing using mirrors.

In the selected group, 58 children suffer from nocturnal apnea, and nasal breathing is completely absent at the time of the study in 43 of them. Some of the children were undergoing treatment with otolaryngologists at the time of the examination.

Below is a comparative table showing the correlation between the type of breathing and specific occlusal anomalies.

When identifying pathological occlusion of a certain type (Class II or Class III Angle's classification) in a child, we observe the presence of respiratory disturbances. The most pronounced pattern of mouth breathing and apnea is seen in children with occlusal anomalies of Class II- distal and deep bite. A similar but less pronounced situation is observed in children with a mesial bite.

The correlation between postural pathology and occlusal anomalies has been

confirmed by years of research. In several studies addressing occlusal problems, a clear link can be observed between these issues and specific forms of musculoskeletal impairment. For instance, researchers have found that cases of distal bite often coincide with hyperlordosis of the cervical spine [151]. During the conducted research, we utilized the assessment and diagnostic data from the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) to provide a simplified description of various forms of postural abnormalities observed in the patient. These pathologies fall under the category of dorsopathies (M40-M43), with our specific interest lying in two groups: M40 – kyphosis and lordosis, and M41 – scoliosis. To understand the characteristic features of each pathology, we referred to the definition provided in the National "Orthopedic" Specialty Guide.

Among the selected group of respondents, pathologies of the musculoskeletal system were observed in 122 children. To identify a clear correlation with malocclusions, we divided this group of children based on the nosological form of their orthopaedic pathology.

Table 20. The distribution of children with postural pathologies (control and experimental groups) (people / %)*

Postural abnormalities	**Total number of children 122 / %**	**Experimental group 58 / %**	**Control group 64 / %**
Kyphosis of the cervical and thoracic spine	42/ 34,4	20 / 16,95	22 /18,18
Lordosis of the cervical and thoracic spine	35/28,6	16 / 13,56	19 /15,7
Scoliosis	45 / 36,8	22 / 18,64	23 /19,01

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

Further analysis was conducted on the encountered nosological forms of musculoskeletal abnormalities to determine any observed pathologies of malocclusion.

Table 21. The relationship between postural abnormalities and the type of malocclusion anomaly in the control and experimental groups (people / %)*

Class of anomalies	Subclass of anomalies	Kyphosis (42 / %)		Lordosis (35 / %)		Scoliosis (45 / %)	
		E 20	C 22	E 16	C 19	E 22	C 23
Group of anomalies based on Class I occlusion	All anomalies	6 / 5,08	3 / 2,48	2 / 1,69	3 / 2,48	1 / 0,85	0
Group of anomalies based on Class II occlusion	Subclass 1	6 / 5,08	7 / 5,79	5 / 4,24	5 / 4,13	11 / 9,32	10 / 8,26
	Subclass 2	2 / 1,69	5 / 4,13	6 / 5,08	7 / 5,79	9 / 7,63	12 / 9,92
Group of anomalies based on Class III occlusion	All anomalies	6 / 5,08	7 / 5,79	3 / 2,54	4 / 3,31	1 / 0,85	1 / 0,83

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

As we can see from the obtained data, each dentofacial anomaly is associated with a certain deformation of the musculoskeletal system. For children with a pronounced Class II malocclusion pathology, scoliotic posture is commonly observed, while lumbar lordosis and kyphosis are more frequently encountered in children and adolescents with mesial malocclusion.

The next selected criterion is the position of the tongue and the attachment of soft tissue tethers (frenula) in the oral cavity of the examined children [168, 243]. This factor plays a crucial role during the formation of the permanent occlusion and the fusion of the bony structures of the upper and lower jaws – the palatal suture and the active growth of the lower jaw. The position and tone of the lingual muscles influence both the position of the teeth – protrusion and retrusion of incisors, as well as the jaws – mesial occlusion, and open bite. As a practice and several studies have shown, actively influencing the tone of the tongue and normalizing the parameters of jaw closure

appears to be possible during the period of permanent occlusion, when the growth processes of the upper and lower jaw bones are activated. During this period, functional appliances and mouse guard trainers can help address this task, which is advisable to be used in conjunction with surgical correction of tongue and lip frenula (if indicated) and speech therapy correction.

Table 22. The relationship between frenulum (frenula) anomalies and incorrect positioning of the lingual muscle with malocclusion anomalies in the control and experimental groups (people / %)*

Class of anomalies	**Subclass of anomalies**	**Shortened frenula (frenula) (64 / %)**		**Incorrect tongue position (79 / %)**	
		E 31	**C 33**	**E 38**	**C 41**
Group of anomalies based on Class I occlusion	All anomalies	16 / 13,56	15 / 12,4	13 / 11,02	14 / 11,57
Group of anomalies based on Class II occlusion	Anomalies of Subclass 1	7 / 5,93	8 / 6,61	4 / 3,39	7 / 5,79
	Anomalies of Subclass 2	5 / 4,24	7 / 5,79	6 / 5,08	6 / 4,96
Group of anomalies based on Class III occlusion- 164	All anomalies	3 / 2,54	3 / 2,48	15 / 12,71	14 / 11,57

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

In the examined group of children, the issue of tongue muscle tone is evenly distributed among all types of malocclusion pathologies, and the same pattern is observed for the attachment of soft tissue frenula in the oral cavity [168]. This can be explained by the extensive pathogenesis of incorrect tongue positioning in the oral cavity, as well as the characteristics of the selected sample of the examined group of children.

The last considered criterion is the issue of early loss of primary and permanent teeth, and as an additional but equally important factor, the delay or absence of the transition from primary to permanent teeth. Often, a child prematurely loses primary or permanent teeth due to two factors: complications of the carious process and as a result of maxillofacial trauma. The first factor is the most important for practising dental professionals and primarily indicates a lack of adequate prevention and promotion among parents and the adult population regarding the necessity of timely treatment of primary teeth. We have previously discussed the prevalence of caries among the examined children, and the impact of caries and tooth loss was addressed in the chapter "Literature Review".

Next, in the form of a table, we will similarly examine the correlation between malocclusion anomalies and the issue of tooth loss and non-eruption.

Table 23. The relationship between dental arch integrity and malocclusion anomaly before the conducted study in the control and experimental groups (people / %)*

Class of anomalies	Subclass of anomalies	Early extraction/loss of primary and permanent teeth		Delayed eruption of permanent teeth	
		E 45	C 43	E 58	C 61
Group of anomalies based on Class I occlusion	All anomalies	12 / 10,17	8 / 6,61	28 / 23,73	26 / 21,49
Group of anomalies based on Class II occlusion	Subclass 1	14 / 11,86	15 / 12,4	11 / 9,32	13 / 10,74
	Subclass 2	15 / 12,71	17 / 14,05	12 / 10,17	13 / 10,74
Group of anomalies based on Class III occlusion	All anomalies	4 / 3,39	3 / 2,48	7 / 5,93	9 / 7 ,44

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

In the examined group of children, we can observe the following clinical picture: the issue of early loss of primary and permanent teeth is evident in individuals with

Class II and Class III malocclusion. This correlates with a global trend: the absence of teeth during the growth stage of the jaws leads to a reduction in the volume of bone tissue, resulting in the development of occlusal anomalies. Delayed tooth eruption is most pronounced in children with Class I malocclusion anomalies – tooth crowding and protrusion. After considering the above-mentioned criteria, we can conclude the importance and necessity of applying additional treatment methods in orthodontic practice and utilizing the capabilities of related specialties.

3.6. Characteristics of the methods used in orthodontic correction

During the conducted study, we employed similar methods of orthodontic correction, with differences lying in the additional adjunctive methods used in the experimental group. Below are the treatment methods applied during the study:

- Functional methods: Myobrace trainers, LM activators, Frankel appliances.
- Mechanical methods (removable and fixed appliances): Schwarz appliances, Marck Ross appliances.
- Combined methods: Twin-Block appliances.
- Edgewise technique: Partial and full bracket systems.

To facilitate the selection in various clinical situations, we utilized the following table for the orthodontist dentist:

Table 24. The methodology of applying orthodontic treatment techniques based on the clinical course of the pathological process

Method of treatment	Age group (preschool / primary school / Secondary school)	Growth stage (I-VI)	Bite type (temporary/ transitional/ permanent)	Root development stage (unformed root / open apex / apex not closed / resorption)	Occlusion of teeth in the lateral segment (Class I, Class II, Class III)
Functional preformed	Preschool	I–II	Temporary/ transitional	Unformed root / unformed apex	All classes
Functional individual	Preschool / primary school	I–III	Temporary/ transitional	Unformed apex / unclosed apex	Class II and III, Class I with open bite
Mechanical removable	Primary school	I–III	Transitional	Unformed apex / unclosed apex	Class I and III
Mechanical non-removable	Primary school /secondary school	I–III	Transitional	Unclosed apex	Class I and III with severe upper jaw constriction
Partial bracket system	Primary school	III–VI	Transitional	Unclosed apex	All classes with upper canine dystopia and lower incisor crowding
Full bracket system	Secondary school	III–VI	Permanent	Not recommended during root resorption	All types of malocclusion including skeletal

During the experimental part of the study, we focused on the following criteria in two patient groups:

- The result of the conducted orthodontic treatment and its stability.

- The effect of joint observation with adjacent specialists.

As mentioned above, in the experimental group, treatment methods identical to the control group were applied, in addition to which additional treatment methods and examinations were implemented. These included a step-by-step modification of the orthodontic treatment plan, starting with appliances of different actions and gradually

transitioning to the use of fixed orthodontic appliances. Examinations were also conducted by specialists such as otolaryngologists, speech therapists, and manual therapists. The outcome of the conducted therapeutic measures was considered to be functional, stable occlusion, a low percentage of relapse, and the absence or correction of accompanying pathologies (posture disorders, mouth breathing, hyper/hypotonicity of the orofacial musculature).

The main emphasis during the experimental phase was placed on providing recommendations to parents and children regarding mandatory visits to related specialists: speech therapists, otolaryngologists, and manual therapists. Children in the control group were informed about the advisory nature of these visits. As a result, we observe a reduction in the number of cases related specifically to functional disorders in the experimental group.

Table 25. Patient selection after conducting the experimental study

Patient selection from the study groups after conducting the research				
Associated criteria of malocclusion anomalies	**Experimental group**		**Control group**	
	118	**%**	**121**	**%**
Nocturnal apnea	17	14,4	23	19
Mouth breathing	11	9,32	21	17,3
Shortened frenulum (tongue-tie)	19	16,1	33	27,3
Incorrect tongue position	30	25,4	34	28
Musculoskeletal disorders	41	39,8	52	43,8
Early extraction/loss of primary and permanent teeth	18	15,2	23	19
Delayed eruption of permanent teeth	28	23,7	39	32,2

Comparing the obtained data, we also observe a similar pattern in all functional groups.

For a more comprehensive picture of the results of the conducted experiment, we examined each accompanying nosology separately.

Table 26. The prevalence of breathing disorders among the investigated groups of children after the treatment (people / %)*

Class of anomalies	Subclass of anomalies	Mouth breathing		Nocturnal apnea	
		Э 11	К 21	Э 17	К 23
Group of anomalies for Class I occlusion	All anomalies	1 / 0,85	-	-	-
Group of anomalies for Class II occlusion	Subclass 1	4 / 3,39	6 / 4,96	8 / 6,78	7 / 5,79
	Subclass 2	3 / 2,5	9 / 7,44	6 / 5,08	9 / 7,44
Group of anomalies for Class III occlusion	All anomalies	3 / 2,5	6 / 4,96	3 / 2,54	7 / 5,79

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

Thus, based on the results of the conducted research, we observe a significant reduction in the number of respondents with Class II occlusion suffering from mouth breathing in the experimental group. This applies to both the first and second subclasses of occlusion. The number of children with mouth breathing and mesial occlusion remained unchanged. We observe a similar pattern among children suffering from nocturnal apnea (Table 26).

Table 27. The prevalence of postural disorders among the investigated groups of children after the treatment (people / %)*

Postural disorders	Total number of children	Experimental group	Control group
Kyphosis of the cervical and thoracic spine	33 / 34,4	13 / 11,02	20 / 16,53
Kyphosis of the cervical and thoracic spine	24 / 28,6	11 / 9,32	13 / 10,74
Scoliosis	36 / 36,8	17 / 14,41	19 / 15,7

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

Based on the overall characterization of the research results, it can be noted that there is a decrease in the prevalence of musculoskeletal disorders both in the control group (from 52.8% to 43.8%) and in the experimental group (from 49.1% to 39.8%). Thus, we can observe a significant decrease in the prevalence of kyphosis of the cervical and thoracic spine in the experimental group, as well as a noticeable decrease in cases of lordosis and scoliosis in both groups (Table 27).

Table 28. The prevalence of postural anomalies among patients after conducting the research (people / %)*

Class of anomalies	Subclass of anomalies	Kyphosis		Lordosis		Scoliosis	
		E 13	C 20	E 11	C 13	E 17	C 19
Group of anomalies for Class I occlusion	All anomalies	1 / 0,85	2 / 1,65	1 / 0,85	1 / 0,83	0	0
Group of anomalies for Class II occlusion	Subclass 1	5 / 4,24	6 / 4,96	3 / 2,54	4 / 3,31	9 / 7,63	8 / 6,6
	Subclass 2	2 / 1,69	5 / 4,13	4 / 3,39	5 / 4,13	8 / 6,78	11 / 9,09
Group of anomalies for Class III occlusion	All anomalies	5 / 4,24	7 / 5,79	3 / 2,54	3 / 2,48	0	0

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

A more detailed examination of postural anomalies depending on occlusion anomalies gives us a complete view of changes in posture among children undergoing orthodontic correction. Thus, we observe a reduction in kyphosis manifestations among children with Class I occlusion in the experimental group. A slight decrease in its manifestations is noted among subjects with Class II and Class III occlusion. A decrease in the prevalence of lordosis is characteristic for children with distal jaw occlusion. No manifestations of scoliosis are observed in children with neutral occlusion, with a

noticeable slight decrease in the second class of occlusion. The view appears to be practically unchanged in children with mesial occlusion (Table 28).

Table 29. The relationship between anomalies of the frenulum (tethers) and incorrect positioning of the lingual muscles with malocclusion anomalies in the control and experimental groups after the conducted experiment (people / %)*

Class of anomalies	**Subclass of anomalies**	**Shortened frenulum (tethers)**		**Incorrect positioning of the tongue**	
		E 19	**C 33**	**E 30**	**C 34**
Group of anomalies for Class I occlusion	All anomalies	5 / 4,24	15 / 12,4	12 / 10,17	11 / 9,09
Group of anomalies for Class II occlusion	Subclass 1	6 / 5,08	8 / 6,61	3 / 2,54	6 / 4,96
	Subclass 2	5 / 4,24	7 / 5,79	5 / 4,24	6 / 4,96
Group of anomalies for Class III occlusion- 164	All anomalies	3 / 2,54	3 / 2,48	10 / 8,47	11 / 9,09

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

The greatest effect of recommendations for performing frenulotomy of the upper lip frenulum and working with speech therapists on correcting the length of the tongue frenulum is observed among children with neutral dental occlusion and anomalies in the positioning of individual teeth. In other cases of DFA, this effect is either not pronounced or weakly pronounced (Table 29). The issue related to the impaired tone of the lingual muscles becomes less pronounced among children with mesial jaw occlusion after the conducted research. The data obtained on the influence of soft tissues at DFA thus correlate with the information described in the chapter “Literature Review”.

Table 30. The relationship between the integrity of the dental arch and malocclusion anomalies in the control and experimental groups after the conducted research (people / %)*

Class of anomalies	Subclass of anomalies	Early removal/loss of primary and permanent teeth		Delayed eruption of permanent teeth	
		E 18	C 23	E 28	C 39
Group of anomalies for Class I occlusion	All anomalies	5 / 4,24	1 / 0,83	9 / 7,63	16 / 13,22
Group of anomalies for Class II occlusion	Subclass 1	3 / 2,54	11 / 9,09	9 / 7,63	8 / 6,61
	Subclass 2	6 / 5,08	10 / 8,26	6 / 5,08	8 / 6,61
Group of anomalies for Class III occlusion	All anomalies	4 / 3,39	1 / 0,83	4 / 3,39	7 / 5,79

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

A similar pattern of reduced frequency of manifestation of etiological factors is observed when considering the quantitative expression of early tooth loss and deviations in the timing of tooth eruption (Table 30).

Furthermore, it is important to provide a detailed description of the characteristics of relapses after the conducted research. During patient examinations and observations following the completion of the experiment, the following regularity was noted: the occurrence of relapse is often accompanied by patient non-compliance with the retention period, such as neglecting the wearing of removable appliances mouse guards and night retainers, as well as breakage of fixed appliances.

Table 31. Degree of recurrence manifestation among patients in the control and experimental groups (people / %)*

Recurrence among the group of etiological factors	Control group 82 from 121 children	Experimental group 49 from 118 children
Breakage of the retention apparatus	13 / 10,74	7 / 5,93
Non-compliance with the appliance-wearing regimen	21 / 17,36	10 / 8,47
Tooth loss due to physiological replacement or carious process	7 / 5,79	4 / 3,39
Shortened frenula	2 / 1,65	0
Impaired tongue muscle tone	15 / 12,4	8 / 6,78
Breathing dysfunction	10 / 8,26	9 / 7,63
Impaired musculoskeletal function	14 / 11,57	11 / 9,32

* percentage calculated from the total number of children in the control group (121 people) and experimental group (118 people)

As we can see in both groups, the frequency of recurrence due to a violation of the retention period is not high and does not exceed 18%. During the experimental phase, our main focus was on providing recommendations to parents and children regarding the mandatory wearing and care of orthodontic retention appliances, as well as encouraging visits to related specialists such as speech therapists, otolaryngologists, and manual therapists. Children in the control group were informed about the advisory nature of these visits. As a result, we observe a decrease in the number of recurrences associated specifically with functional disorders of the orofacial musculature (6.78%) in the experimental group, particularly due to tongue muscle activity (Table 31).

Upon comparing the obtained data, we also observe a similar pattern in all three functional groups of recurrences (related to orofacial musculature, respiratory system, and musculoskeletal system). In all of these groups, we observe a reduction in their frequency in the experimental group of patients.

To provide a more comprehensive picture of the recurrences in orthodontic treatment, we examined each associated nosology separately. From the presented data, we observe that children with mouth breathing in both the control and experimental groups frequently experience recurrence after orthodontic treatment (8.26% and 7.63% respectively). Based on this, several conclusions can be drawn. Firstly, mouth breathing

is more difficult to correct in the age groups under consideration. Secondly, it is more reactive in terms of recurrence formation compared to other forms of breathing disorders. This can be explained by several factors. Firstly, research has shown that mouth breathing is often not an independent nosological form and occurs against the background of an underlying condition. The scientific literature has demonstrated the association of this form of breathing with various forms of asthma, obstructive sleep apnea, and adenoid hypertrophy. Secondly, the occurrence of mouth breathing can trigger a series of adaptive mechanisms aimed at increasing the body's air consumption. Some authors also note postural anomalies in children with mouth breathing. Therefore, when a child has this form of breathing pathology, it is necessary to address a complex of associated pathologies.

Table 32. Recurrence of occlusion anomaly in children with musculoskeletal pathology (people / %)*

Postural disorders	Control group	Experimental group
	14	11
Kyphosis of the cervical and thoracic spine	3 / 21,43	2 / 18,18
Lordosis of the cervical and thoracic spine	7 / 50	6 / 54,55
Scoliosis	4 / 28,57	3 / 27,3

* percentage calculated from the total number of children with pathology of the musculoskeletal system in the control (14 people) and experimental groups (11 people)

Summing up the interim results based on the data on musculoskeletal pathologies, the following conclusion can be drawn. Children with kyphosis of the cervical and thoracic spine are most susceptible to the risk of recurrence (Table 32). This can be largely explained by the following factors:

- violation of the retention period of orthopaedic posture correction,
- lack of postural correction.

The recurrence of occlusion anomaly in these situations arises as a compensatory measure by the child's body.

When discussing the muscle tone of the maxillofacial region, we should refer back to the data presented in the section 'Etiology and Pathogenesis of Malocclusions.' Reduced muscle tone in this area of the human body can lead to malocclusions, just like hypertonicity. Accordingly, during the course of the experiment and when providing recommendations to patients and parents, our goal was to achieve a harmonious muscle tone in the maxillofacial region.

Table 33. The degree of recurrence manifestation after conducting the study among patients with tongue muscle tone disorders and soft tissue tethering pathologies (people / %)*

Type of disorders	Control group	Experimental group
	15	8
Tongue muscle tone disorder (hypertonicity))	9 / 60	5 / 62,5
Tongue muscle tone disorder (hypotonicity)	6 / 40	3 / 37,5

*percentage calculated from the total number of children with impaired tongue tone and pathology of soft tissue cords in the control group (15 people) and experimental group (8 people)

Examining the detailed table of recurrences associated with pathological muscle tone, we can observe the following pattern: the most pronounced recurrent pattern is seen in patients with hypertonicity of the maxillofacial muscles (Table 33). Increased tongue muscle tone, particularly when combined with incorrect tongue position in the oral cavity and infantile swallowing pattern, often poses the greatest risk.

Summarizing the experimental part of this study, the following conclusions can be drawn:

- in both cities under consideration, there is a high prevalence of malocclusions in the selected groups of children;

- the high prevalence is characteristic across all age groups examined;

- there is no significant gender dimorphism in occlusion anomalies within the examined groups;

- in the majority of children within the examined groups, there are accompanying pathologies that contribute to the development of DFA or exacerbate their progression;

- when creating treatment plans in the experimental and control groups, adjustments were made to account for the presence of these pathologies in the child;

- during follow-up examinations, a decrease in the number of recurrences was observed in the experimental group.

CHAPTER 4. RESULTS OF THE CONDUCTED SOCIOLOGICAL STUDY

4.1. Motivation of orthodontists to implement a prophylaxis program for patients with malocclusion anomalies

The purpose of conducting the questionnaire is to study the essence of the questionnaire survey and analyze its results for their further application in the development of a malocclusion anomaly prevention program.

Before conducting this stage of the research, the following tasks were set:

- collecting comprehensive information on the most frequently encountered nosological forms of malocclusion anomalies;

- obtaining data on the most current methods of orthodontic correction;

- analyzing data on patients' need for orthodontic treatment;

- detailed acquaintance with the surveyed audience (doctors, parents, and children who participated in the study) to identify their needs.

The first stage of the sociological research involved surveying orthodontist dentists in Tyumen and St. Petersburg. A total of 120 doctors from the mentioned cities participated in the survey. The doctor's questionnaire consisted of 21 questions (appendix A) aimed at gathering information about their experience, clinical approach to work, diagnostic and treatment methods for occlusal anomalies, and their attitude towards preventive measures.

The first question of the questionnaire aimed to determine the years of work experience of the participating doctors in the research.

Table 34. The years of work experience of the dental doctors

Work experience	Qty	Percent
1-5 years	47	39,5
5-10 years	54	45,4
10-20 years	15	12,6
20+ years	3	2,5
Total	120	100,0

As we can see in the table presented above, the majority of surveyed clinicians have professional experience in the field of Orthodontics for up to 10 years (45.4%). A smaller number of doctors have experience of less than 5 years (39.5%) and from 10 to 20 years (12.6%). 2.5% of the surveyed doctors have a professional experience of over 20 years. This result indicates that the majority of surveyed doctors are young, novice specialists with a developing clinical experience and mindset, including their approach to preventive methods.

Table 35. The number of specializations among orthodontist dentists

Number of specializations	Qty	Percent
Only one specialization	87	72,5
Two and more specializations	33	27,5
Total	120	100,0

Next, we found that the majority of respondents have only one specialization in the field of orthodontics (72.5%), while 27.5% of doctors have two or more specializations (Table 35). This indicates the potential isolation of orthodontics as a professional field, even when compared to other dental specialities.

Table 36. How long ago did you undergo professional development training (CME/scheduled periodic)?

Years ago	Qty	Percent
Less than a year ago	45	37,5
From 1 to 4 years ago	67	55,8
From 4 to 5 years ago	8	6,7
Total	120	100,0

The majority of surveyed specialists underwent professional development training between 1 and 4 years before the conducted research (55.8%). 37.5% of doctors underwent training within 1 year, and 6.7% underwent training 4 to 5 years ago (Table 36). These results indicate the regularity of planned certifications and state examinations among the surveyed doctors.

Table 37. The frequency of attending courses and masterclasses in the field of "Orthodontics".

Frequency	Qty	Percent
1–2 times every 6 months	42	35,0
1–2 times a year	46	38,3
Once a year or less	23	19,2
Unsure how to answer	9	7,5
Total	120	100,0

The majority of doctors undergo training and attend masterclasses in the field of orthodontics 1-2 times within a calendar year (35%). A slightly smaller percentage of doctors engage in professional development through training programs 1-2 times within six months (38.3%). 19.2% of doctors receive training once a year or less, and 7.5% of respondents were unsure how to answer the question (Table 37). These results can be interpreted as follows: the overwhelming majority of respondents have the desire and opportunity to enhance their knowledge and skills. The remaining clinicians may have different preferences or constraints that affect their frequency of attending such educational activities. Indeed, the remaining clinicians may have various reasons that hinder their ability to participate in such educational events.

Table 38. Number of specializations for training

Answer options	Qty	Percent
Unsure how to answer	34	28,3
I attend studies only in orthodontics	48	40,0
I attend studies in all my specializations	38	31,7
Total	120	100,0

The majority of clinicians (40%) primarily focus on attending training and masterclasses related to their main specialization, which is orthodontics (Table 38). Additionally, 31.7% of doctors seek to enhance their skills and knowledge across all their specializations. However, it is worth mentioning that 28.3% of respondents were unsure how to answer the question. Overall, it can be inferred that a significant portion of the surveyed doctors regularly engage in professional development to improve their manual skills and theoretical knowledge. On the other hand, only a small percentage of

respondents prioritize the development of clinical skills across all their specializations (31.7%).

Table 39. Participation of doctors in preventive activities

Types of preventive activities	Qty	Percent
Mass screenings in kindergartens/schools	54	45,0
Joint examination of children with predisposition to the development of malocclusion anomalies with specialists from related fields.	54	45,0
Oral cavity sanitation in pregnant women.	8	6,7
Consultations for pregnant women and couples planning to have a child (identification of the presence of anomalies).	19	15,8

The majority of surveyed clinicians, in one way or another, participated in preventive activities, more often in screenings of schoolchildren and preschoolers, as well as in joint examinations of children with specialists from related fields (45%). In one form or another, 6.7% and 15.8% of doctors conducted preventive measures for DFA in children of expectant mothers (Table 39). It should be noted that the examinations of children by doctors from state clinics in educational and preschool institutions are regulated by legislation (Order of the Ministry of Health of the Russian Federation dated November 13, 2012, No. 910n "On the Approval of the Procedure for Providing Medical Care to Children with Dental Diseases" (with amendments and additions) [72]), therefore, in this case, there is a specific attachment of the doctors to these organizations.

Table 40. Referral of the patient to related specialists, including those who are not of a dental speciality.

Field of specialization	Very often	Quite rarely	Isolated cases	Almost never referred	Total
Dentists, including dental hygienists	67,5	20,8	11,7	0,0	100,0
Otorhinolaryngologist	45,0	24,2	9,2	21,6	100,0
Speech therapist	29,2	32,5	15,8	22,5	100,0
Paediatrician	22,5	9,2	18,3	50,0	100,0
Manual therapist/osteopath	6,8	15,4	10,3	67,5	100,0
Maxillofacial surgeons	11,8	9,2	47,9	31,1	100,0

The question of consultations with related specialists is relevant to our topic, as the "Literature Review" chapter demonstrates that DFA is a multifactorial problem that cannot be solved solely within the framework of orthodontic treatment. Therefore, it is not surprising to see a high level of responses regarding involvement in collaboration with other doctors (Table 40). In terms of patient preparation and rehabilitation, as well as collaboration with dental doctors (67.5%), addressing nasal breathing issues (45%), and working with the tone of the lingual and facial muscles (29.2%), the surveyed doctors interact less frequently with paediatricians (50% do not collaborate), osteopaths (67.5% do not refer), and maxillofacial surgeons (11.8% consult or have joint appointments). These survey results are partly understandable. It is worth mentioning again the absence of a preventive program for occlusal anomalies and, as a result, the lack of a "roadmap" for interaction between orthodontists and pediatric doctors. The infrequent collaboration between orthodontists and maxillofacial surgeons can be explained by the rarity of complex combined treatment cases in the practice of an individual doctor, as well as the high cost and limited accessibility of surgical interventions. The infrequent collaboration with osteopaths can be explained by the limited scientific evidence base of this alternative medical method specifically targeting occlusal anomalies [152].

Table 41. The age of the patient to begin preventive examinations with an orthodontist

Age	Qty	Percent
0–1 years old	15	12,5
1–6 years old	75	62,5
6–12 years old	27	22,5
12 years and older	3	2,5
Total	120	100,0

During conversations with doctors about the prevention of occlusal anomalies, an important question was the age at which observation should begin with an orthodontic dentist (Table 41). Most commonly, doctors indicated an age range of 1-6 years (62.5%), significantly fewer mentioned 6-12 years (22.5%), and a small number of

doctors believe that the prevention of occlusal anomalies can be carried out before the age of 1 year and beyond 12 years of age (12.5% and 2.5% respectively). In the paragraph "Etiology and Pathogenesis of Malocclusion Anomalies", the importance of controlling the timely eruption of teeth in children to prevent the development of occlusal pathology was described.

Table 42. Distribution of responses regarding the feasibility of creating and implementing a preventive program for malocclusion anomalies in clinical practice among healthcare professionals

Responses	Qty	Percent
Yes	87	72,5
No	33	27,5
Total	120	100,0

The last question posed to the surveyed doctors was about the advisability and feasibility of implementing a separate program for the prevention of malocclusion anomalies. According to the results of the question, 72.5% responded positively, while 27.5% responded negatively (Table 42). Such a final result can be interpreted in two ways. Firstly, it has been proven that malocclusion anomalies are not only a disease of the oral cavity but also a pathological process that comprehensively affects the health of both the oral cavity and other organs and systems. However, secondly, the absence of prevention and treatment algorithms, as well as a unified etiological concept for the development of DFA, are the reasons for the absence of a preventive program for occlusal anomalies.

4.2. Sanitary and hygienic knowledge and motivation towards the health of the oral cavity organs in patients with maxillofacial pathology

A total of 423 children aged 6 to 14 years, residents of St. Petersburg and Tyumen, participated in the survey, including 181 boys and 242 girls aged 6 to 12 years.

Among them, 202 were residents of St. Petersburg, and 221 were children residing in Tyumen.

The children were distributed by age as follows:

Preschool age (6 years) – 102 children: 43 boys and 59 girls.

Younger school-age group (7 to 10 years) – 213 individuals, including 96 boys and 117 girls.

Middle school-age group (11 to 14 years) – 108 individuals, 41 boys, and 67 girls (Table 43; Table 44).

Table 43. Distribution of respondents by gender

Gender	Qty	Percent
Female	242	57,2
Male	181	42,8
Total	423	100,0

Table 44. Distribution of respondents by age

Age	Qty	Percent
6	102	24,1
7	58	13,7
8	68	16,1
9	54	12,8
10	33	7,8
11	38	9,0
12	17	4,0
13	34	8,0
14	19	4,5
Total	423	100,0

The majority of respondents (71.9%) live in a complete family, 17% live in a single-parent family, 8.7% live with only a grandparent, and 2.41% live with a guardian.

The survey was conducted in the presence of parents and legal representatives of the child following Article 28 of the Civil Code of the Russian Federation, Article 64 of the Family Code of the Russian Federation, Article 20 of Federal Law No. 323-FZ "On

the Basics of Citizen Protection in the Russian Federation," paragraph 4 of Article 4, and paragraph 4 of Article 22 of Federal Law No. 323-FZ "On the Basics of Citizen Protection in the Russian Federation." The questionnaire consisted of 16 questions (Appendix C), with response options ranging from 3 to 5 choices.

The survey was conducted using the online survey service "Google Forms". Among the key advantages of this method are its speed, allowing for a quick survey of the required number of patients; convenience for respondents, as they can complete the survey using their smartphones; and strict regulation of the procedure, significantly reducing the number of skipped questions by setting certain questions as mandatory in the settings. Furthermore, online surveys allow for the elimination of the interviewer effect and increase the sincerity of responses due to the anonymity of the respondents.

The link to the online questionnaire page was provided to individuals accompanying the children to the dental office, including parents, grandparents, and others. The invitation to participate in the survey was carried out directly at the medical institution.

Patient surveying aims to collect information about the collective or individual opinions of the respondents (children) regarding dental health, preventive and treatment methods, and to identify the reflected information in their awareness about bite abnormalities and possible corrective measures. This information is expressed in the form of statements made by the respondents regarding the fixed empirical (in the form of questions) research tasks and categories of analysis.

To achieve this goal, the following tasks were set for conducting the survey:

- identifying the skills and practices of oral hygiene;
- determining the motivation and commitment to long-term orthodontic treatment;
- assessing the awareness of the ongoing orthodontic treatment.

After obtaining general information (gender, age, family composition), a question was asked about the frequency of dental care. The data obtained from the analysis of the questionnaires are presented in Table 45.

Table 45. Frequency of dental care

Frequency of care	Qty	Percent
Yes	265	62,6
I brush my teeth once a day	103	24,3
I brush my teeth periodically	55	13,1
Total	423	100,0

As a result of the survey, it was found that 62.6% of respondents have knowledge about the necessity of regular oral and dental care. Additionally, 24.3% of those surveyed clean their teeth once a day and 13.1% take care of their oral cavity periodically. This indicates either a lack of knowledge and insufficient awareness about the importance of thorough oral care, or a lack of positive examples and motivation for dental care. The overall high percentage of regular dental care (86.9% of respondents from Saint Petersburg and Tyumen) indicates a fairly good level of awareness among children aged 6 to 14 about the necessity of regular dental care. The high percentage of regular dental care in major cities (such as Saint Petersburg and Tyumen) may be explained by the existing active preventive work in promoting oral health. During the survey, the regularity of dental care was identified among children aged 4 to 14, depending on the gender of the respondent.

Table 46. The regularity of dental care depending on the gender of the respondent

			Gender of respondent		Total
			Female	Male	
Do you regularly brush your teeth in the morning and evening?	Yes	Quantity	171	94	265
		%	70,7	51,9	62,6
	I brush my teeth once a day	Quantity	43	60	103
		%	17,8	33,1	24,3
	I brush my teeth periodically	Quantity	28	27	55
		%	11,6	14,9	13,0
Total		Quantity	242	181	423
		%	100,0	100,0	100,0

The analysis of the obtained data showed that girls in all age groups engage in dental care twice a day more frequently (70.7%) compared to boys (51.9%) (Table 46). This result can be explained by the particularities of girls' earlier self-awareness as representatives of the female gender and their desire to emphasize their appearance to meet the expectations and demands of the "female gender role" [200]. This is also associated with a lower percentage of the response "I clean my teeth periodically" – 11.6%, compared to male respondents – 14.9%.

The following question, "How often do you visit the dentist?" was intended to determine how regularly children from three age groups, ranging from 6 to 14 years old, visit the dentist together with their parents or legal guardians.

Table 47. The frequency of dental visits depending on the age of the patient

Age group	Once every 6 months	No more than once a year	Visited but a very long time ago	Never visited	Unsure how to answer	Total
Preschool	37,3%	43,1%	14,7%	3,9%	1,0%	100,0%
Primary school	54,0%	31,0%	10,3%	2,8%	1,9%	100,0%
Secondary school	36,1%	37,9%	16,7%	7,4%	1,9%	100,0%
Total	45,4%	35,7%	12,9%	4,3%	1,7%	100,0%

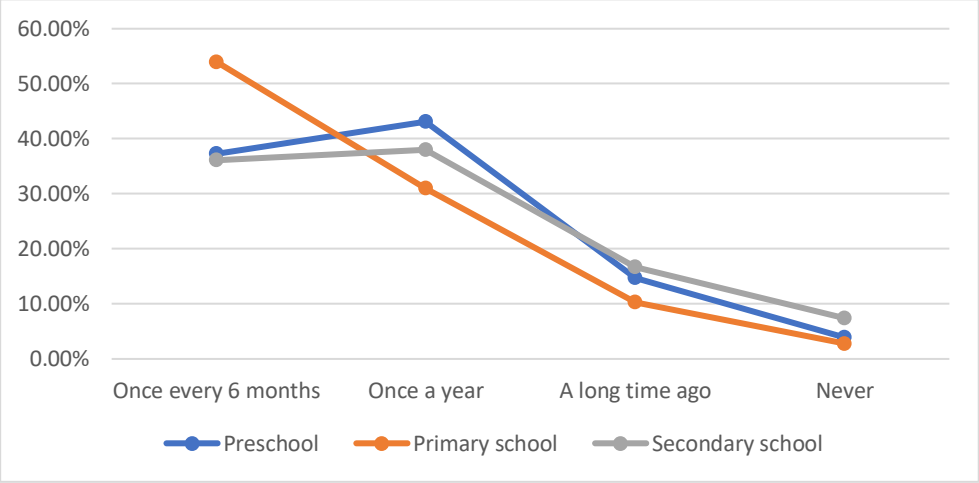


Fig. 20. The frequency of dental visits depending on the age of the patient

A greater number of preschoolers and young schoolchildren visit the dentist once every six months (overall percentage – 91.3%) more frequently than middle schoolchildren (36.1%) (Table 46, Figure 20). This fact is associated with the tooth transition process in preschoolers, which requires adjustments to their growth (strengthening teeth, removal of loose teeth, fluoridation, and silvering). Among middle schoolchildren, a higher percentage is noted compared to other age groups for the following response option: "Visited, but a long time ago" – 16.7% (preschoolers – 14.7%; young schoolchildren – 10.3%).

Such responses may be associated with the specificity of time perception in children, which varies at different ages [223], the absence of concerning factors, as well as social factors (families with low income may not always afford private visits to the dentist). In children of preschool and young school age groups, the perception of time intervals is associated with play activity and is tied to the family. As the child grows older, the association of certain events with the concept of hours and exact time develops. In the age range of 12 to 17, there is an adaptation of the time concept in relation to various regular events – going to school, extracurricular activities, and so on. The response option "Never visited" was given by 7.4% of respondents in the middle school age group. This response option may be associated with the absence of complaints about pathological processes in the oral cavity in children, as well as with social and psychological factors. Only 3.9% of preschoolers and 2.8% of young schoolchildren gave a similar response (this fact may be explained by the specificity of memory in preschoolers and young schoolchildren, as well as the absence of negative experiences in communicating with a dentist)

Table 48. The presence of dental treatment experience depending on the patient's age

Age group	Have experience	Have no experience	Unsure how to answer	Total
Preschool	47,1%	44,1%	8,8%	100,0%
Primary school	77,0%	10,8%	12,2%	100,0%
Secondary school	66,7%	18,5%	14,8%	100,0%
Total	67,1%	20,8%	12,1%	100,0%

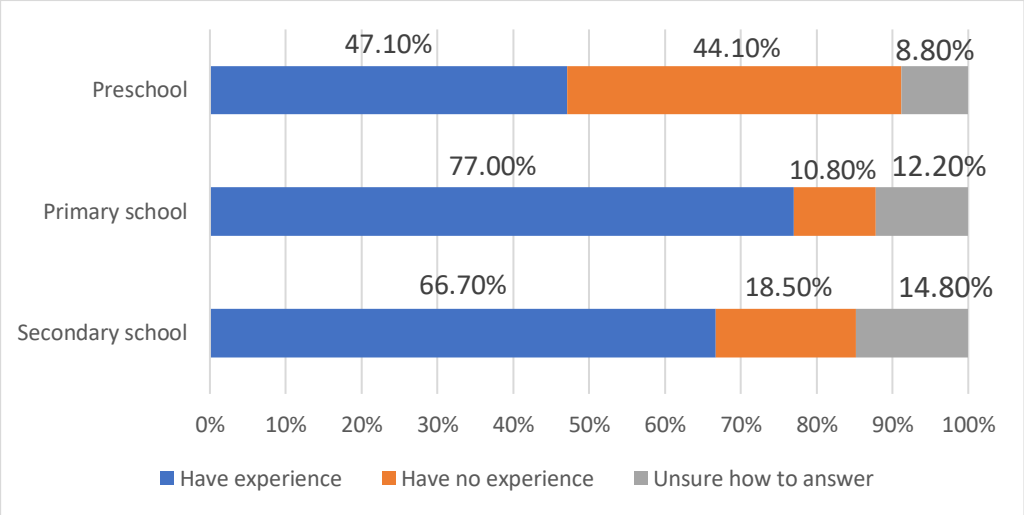


Fig. 21. The presence of dental treatment experience depending on the patient's age

The majority of respondents in all age groups have dental treatment experience – 67.1% (preschoolers – 47.1%; young schoolchildren – 77%, middle schoolchildren – 66.7%), which is supported by several studies [219, 256]. It should also be noted that with the transition to schooling, children's dietary quality changes (it is no longer as carefully controlled by parents, and children consume more products containing fast carbohydrates, which are abundant in school cafeterias) [52]. Younger and middle schoolchildren cannot independently determine the degree of benefit or harm of various food products. Analysis of studies dedicated to this topic shows that often children cannot navigate products that are potentially harmful to the oral biome [62]. Parents and school teachers are also insufficiently informed about the food products consumed by schoolchildren and their impact on the oral health of the child. In the chapter "Literature Review," we have described the influence of diet on the occurrence of occlusal anomalies in children. In this context, we would like to mention once again the study by Begg and Kessling, which has demonstrated the impact of soft carbohydrate food on the development of tooth crowding [156].

Table 49. Difficulties with nasal breathing depending on the patient's age

Age group	Dificulties were encountered	Dificulties were not encountered	Unsure how to answer	Total
Preschool	38,2%	48,1%	13,7%	100,0%
Primary school	31,9%	51,2%	16,9%	100,0%
Secondary school	47,2%	42,6%	10,2%	100,0%
Total	37,4%	48,2%	14,4%	100,0%

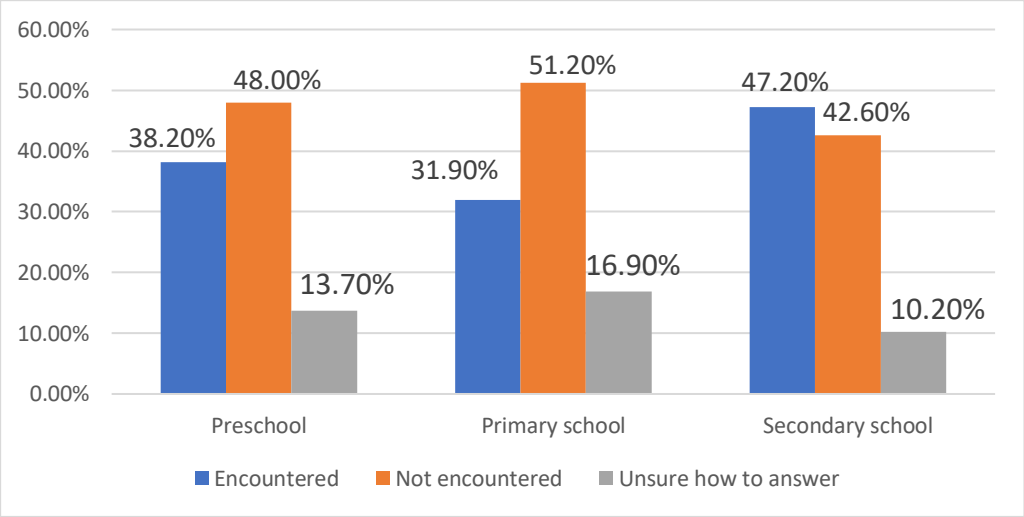


Fig. 22. Difficulties with nasal breathing depending on the patient's age

In the chapter "Literature Review," the influence of respiratory tract pathologies on the process of occlusal anomaly formation was described. During the sociological survey, a question was posed regarding issues related to physiological nasal breathing problems in children of different age groups (Table 49, Figure 22). Thus, the following pattern can be observed: in all three age groups, to some extent, there were problems with nasal breathing (38.2% preschool group, 31.9% lower school, 47.2% middle school). However, it is impossible to fully examine the issue of oral breathing problems without analyzing the following research question.

Table 50. The frequency of occurrence of respiratory infections depending on the patient's age

Age group	Often	Not often	Unsure how to answer	Total
Preschool	21,6%	56,8%	21,6%	100,0%
Primary school	46,0%	28,2%	25,8%	100,0%
Secondary school	29,6%	53,7%	16,7%	100,0%
Total	35,9%	41,6%	22,5%	100,0%

In Chapter 1 of the study, the pathogenetic picture of oral breathing as a trigger for inhibiting mandibular development and maxillary growth was described. Based on the conclusion of the health monitoring report for the population of the Russian Federation in 2020, respiratory infections of infectious aetiology accounted for 88% of all infectious and parasitic diseases, causing not only harm to human health but also significant economic damage [71]. This once again emphasizes the importance of prevention not only of DFA but also of accompanying processes and factors that influence their development. Based on the results of the conducted survey (Table 50), 35.9% of children from all age groups frequently suffer from respiratory infections. Among these, lower school children (46.0%) are more susceptible to diseases of the nasal and pharyngeal organs. Then, as the child grows older, the number of individuals affected decreases, reaching 29.6%. This pattern can be explained by adaptive and acquired immunity (due to vaccinations conducted in schools and the child's contact with a larger number of people, such as classmates, teachers, children from extracurricular activities, etc.) [254, 55].

Table 51. The frequency of warnings by teachers (educators) or parents regarding posture, depending on the patient's age

Age group	There were warnings	There were no warnings	Unsure how to answer	Total
Preschool	74,5%	19,6%	5,9%	100,0%
Primary school	55,8%	35,7%	8,5%	100,0%
Secondary school	53,7%	32,4%	13,9%	100,0%
Total	59,8%	31,0%	9,2%	100,0%

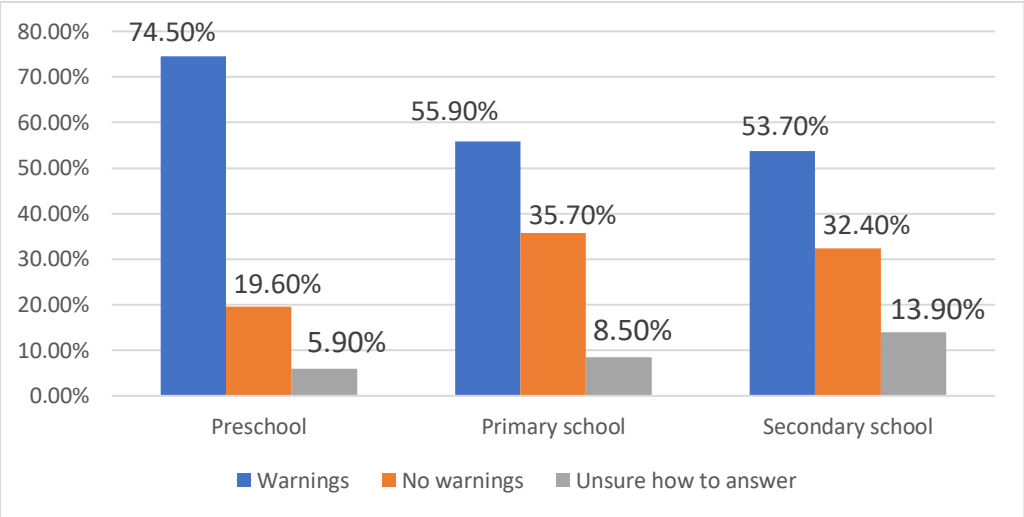


Fig. 23. The frequency of warnings by teachers (educators) or parents regarding posture, depending on the patient's age

During the survey, respondents aged 6 to 14 years answered questions regarding the characteristics and assessment of their posture by adults (teachers, parents, doctors), as well as providing their own evaluation of their posture. 59.8% of the respondents reported receiving comments and warnings about their posture (among them: preschoolers – 74.5%; lower school students – 55.9%; middle school students – 53.7%). The obtained results indicate increased monitoring of children's posture by parents, doctors, and educators of 6-year-olds and lower school students who are adapting to new forms of life activities (such as studying) (Table 51, Figure 23). During this time, there is an adaptation to the new conditions of the educational process, which includes prolonged sitting at a desk, which is not entirely familiar for children aged 6-8, as well as carrying heavy backpacks. These factors do not always affect body posture, including posture. Questioning parents on this issue also revealed insufficient awareness of this problem, which, combined with the children's responses, indicates a lack of knowledge among the common people.

Table 52. Self-perceived characterization of posture depending on the patient's age

Age group	Good	Normal	Not bad	Bad	Unsure how to answer	Total
Preschool	43,1%	18,6%	16,7%	11,8%	9,8%	100,0%
Primary school	40,4%	28,2%	19,7%	5,6%	6,1%	100,0%
Secondary school	26,9%	27,8%	25,9%	11,1%	8,3%	100,0%
Total	37,5%	25,8%	20,6%	8,5%	7,6%	100,0%

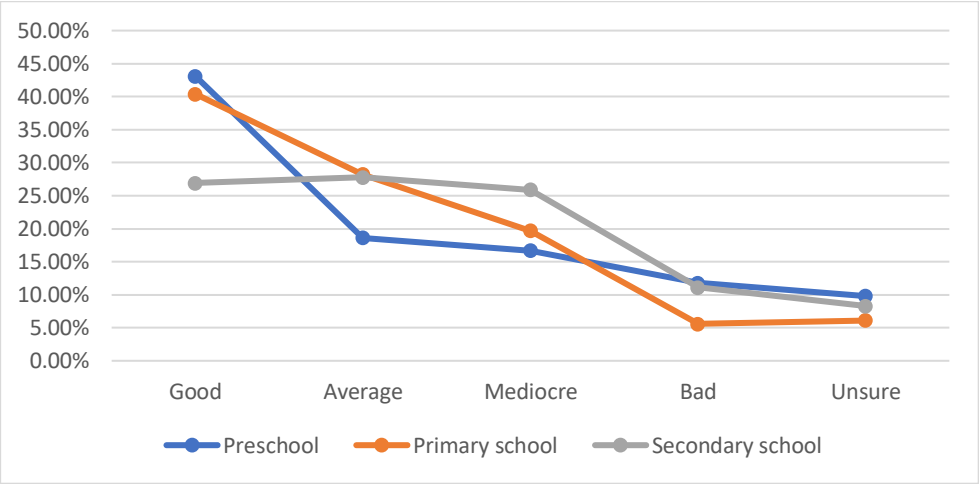


Fig. 24. Self-perceived characterization of posture depending on the patient's age

37.5% of the respondents consider their posture to be good (among them: preschoolers – 43.1%; lower school students – 40.4%; middle school students – 26.9%), indicating a lack of objective self-perception (Table 52, Figure 24). Children of this age do not understand the importance of this factor in the overall assessment of their health [197]. Many preschoolers and lower school students have not yet developed a proper working posture, exhibit asymmetrical shoulder positioning, and show a significant inclination of the torso and head. All of this leads to a disruption of posture, improper coordination of body and neck muscles, and, as a consequence, the pathology of jaw bone development.

The obtained data also indicate insufficient informational efforts in shaping the understanding of the importance of proper posture for human health. Furthermore, 8.5% of the respondents rated their posture as "poor," and 7.6% had difficulty answering the question (among them: preschoolers – 9.8%; lower school students – 6.1%; middle school students – 8.3%). Summarizing the obtained results and comparing them with the literature sources [215] on this matter and the responses received, it can be

concluded that children, regardless of their age, cannot often objectively assess their overall health status, including the oral cavity. This also applies to posture and its influence on occlusal abnormalities.

Table 53. The experience of visiting an orthodontist dentist depending on the patient's age

Age group	There was a previous experience	There was no previous expierence	Unsure how to answer	Total
Preschool	41,2%	42,1%	16,7%	100,0%
Primary school	53,5%	39,4%	7,1%	100,0%
Secondary school	81,5%	14,8%	3,7%	100,0%
Total	57,7%	33,8%	8,5%	100,0%

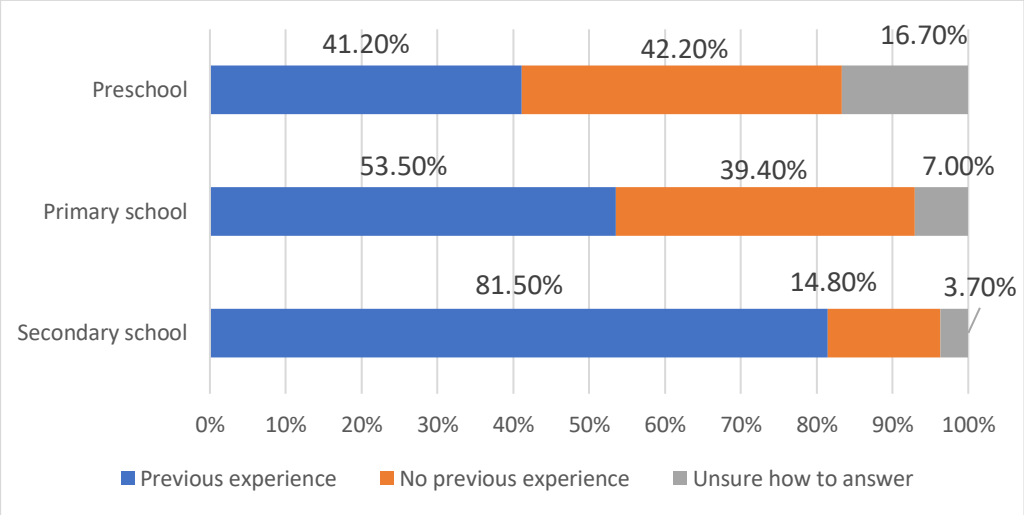


Fig. 25. The experience of visiting an orthodontist dentist depending on the patient's age

Based on the obtained data, it has been revealed that the majority of respondents from all age groups have experience visiting an orthodontist dentist – 57.7% (preschoolers – 41.2%, lower school students – 53.5%, middle school students – 81.5%) (Table 53, Figure 25). Preschoolers do not always come to the orthodontist consciously; they are brought by their parents either by their own will or based on the advice of other specialists. Middle school students often want to correct their appearance themselves, as this is the time when sexual maturation begins, along with the rapid development and restructuring of all organs, tissues, and systems of the body. The middle school age is

associated with the onset of sexual attraction and related thoughts, feelings, experiences, and a special interest in the opposite sex. As a result, there is a critical attitude towards one's appearance and a desire to make it more aesthetically pleasing. Modern children are well aware that an orthodontist can assist in this process. Orthodontic treatment can help correct existing dysfunctions of the dental jaw system, achieve an aesthetically pleasing alignment of teeth, and correct the facial profile, which is important for the formation of a dignified appearance.

Table 54. Attitude towards one's bite/appearance of teeth depending on the patient's age

Age group	Positive	Negative	Unsure how to answer	Total
Preschool	75,5%	18,6%	5,9%	100,0%
Primary school	49,8%	33,8%	16,4%	100,0%
Secondary school	48,1%	34,3%	17,6%	100,0%
Total	55,6%	30,2%	14,2%	100,0%

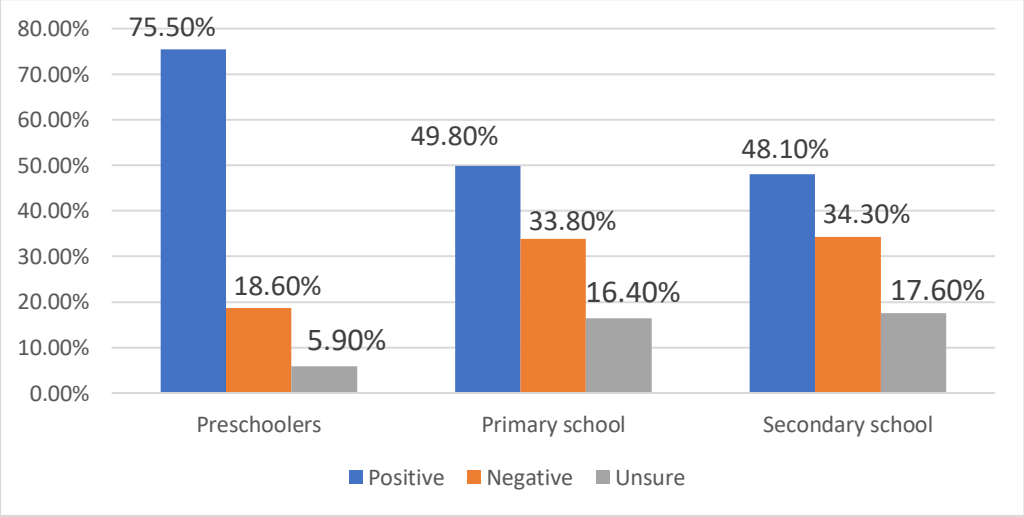


Fig. 26. Attitude towards one's bite/appearance of teeth depending on the patient's age

Through analyzing the responses regarding their own attitude towards their bite, it has been revealed that 55.6% of the respondents from all groups have a positive perception of the appearance of their teeth (Table 54, Figure 26). Among them: preschoolers – 75.5%, lower school students – 49.8%; middle school students – 48.1%.

The self-esteem of a preschool-aged child is formed based on their own opinion of themselves. According to the theory of E. Erikson [139], a preschooler's self-perception (including their appearance) is formed based on the evaluation of their physical abilities and appearance. Six-year-old preschoolers are often satisfied with their appearance because their social interactions are built on trust in themselves and their parents, on self-sympathy, and their perception of the world, rather than negative emotions. Their self-esteem is usually inflated, as the opinion of parents, whose authority is important for the child, plays a significant role in its formation. As E. Erikson noted: "The emerging sense of trust in the child forms the basis of the sense of identity, which later combines three feelings: firstly, that everything is fine with them, secondly, that they are being true to themselves, and thirdly, that they are becoming who other people hope to see in them" [139, P. 113]. Only 18.6% of preschoolers gave a negative assessment of the appearance of their teeth, which also confirms their high self-esteem and their specific perception of the surrounding world. The findings also indicate that children of this age do not yet fully comprehend the importance of their appearance and do not understand the necessity and real possibilities of orthodontic treatment. The results of the survey indicated that 49.8% of elementary school students and 48.1% of middle school students gave a positive evaluation of the appearance of their teeth (compared to 75.5% positive evaluations by preschoolers). Additionally, there was an increase in the negative evaluation of teeth appearance: 33.8% for elementary school students and 34.8% for middle school students (compared to 18.6% among preschoolers). It should be noted that there were changes in the data reflecting uncertainty in responses ("I find it difficult to answer"): preschoolers – 5.9%, elementary school students – 16.4%, middle school students – 17.4%. During this period, a child enters the stage of personality development that Erik Erikson defined as the "psychosocial moratorium." The younger and middle school student actively integrates into society, and as Erik Erikson observes, the "significance of the father and mother figures recedes into the background." School not only introduces a child to new scientific knowledge but also to complex knowledge and various forms of social interaction with different people. At this stage, the child not only learns but also wants

to be liked by their friends and representatives of the opposite sex. According to Erik Erikson, "the child in this case experiences despair from their clumsiness in the world of tools and sees themselves as doomed to mediocrity or inadequacy." As a result, feelings of dissatisfaction with one's abilities and skills, actions, and appearance arise, including the quality and appearance of teeth, bites, etc. The obtained results are supported by the data of the contingency table "Presence of communication difficulties with friends, classmates due to bite problems – depending on the patient's age." These findings are also confirmed by studies of schoolchildren in Moscow conducted by Alimsky A.V., and Smolina E.S. [6, 7, 8, 9, 33, 104].

Table 55. Presence of communication difficulties with friends, classmates due to bite problems – depending on the patient's age

Age group	Difficulties were present	Difficulties were not present	Unsure how to answer	Total
Preschool	17,6%	57,8%	24,5%	100,0%
Primary school	39,4%	43,7%	16,9%	100,0%
Secondary school	34,3%	59,3%	6,5%	100,0%
Total	32,9%	51,1%	16,1%	100,0%

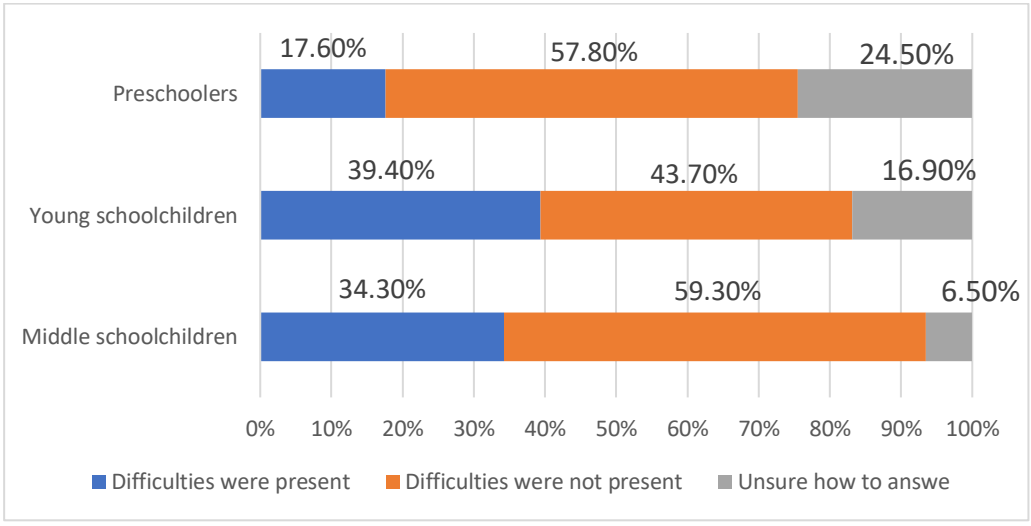


Fig. 27. Presence of communication difficulties with friends, classmates due to bite problems – depending on the patient's age

17% of preschoolers reported having problems with their peers, which they believe were due to an unattractive bite (the majority, 90%, stated that they were

directly told about it and were given unpleasant nicknames as a result). 39.4% of elementary school students claim that they find it difficult to establish relationships with classmates and peers due to bite problems, as these problems cause discomfort in social interactions (Table 55, Figure 27). They feel self-conscious about their appearance and believe that others may not feel comfortable interacting and befriending them as a result. Approximately 34.3% of secondary school students believe that an improper bite hinders their ability to build relationships with individuals of the opposite sex. It is during this time that a certain perception of beauty is formed, along with a desire to conform to these criteria [79]. This stage of human development, according to E. Erikson, is considered significant in the process of forming one's identity [139]. It is during this period that a comprehensive understanding of one's "self" is formed, in which external appearance plays a significant role. As noted by contemporary researchers, in recent years there has been an increased critical attitude towards their appearance among younger and middle-aged schoolchildren. Children of this age group, influenced by the media and the internet, associate an attractive external appearance with life success, a successful career, good relationships with friends, and the opposite sex. However, it should be noted that 24.5% of preschoolers, 16.9% of primary school children, and 6.5% of secondary school students had difficulty answering this question, which reflects the complexity of the process of identification and the formation of a comprehensive self-concept and social relationships.

All participants of different age groups were asked about their experience with orthodontic appliances (Table 56).

Table 56. Experience of using orthodontic appliances depending on the patient's age

Age group	There was an experience	There was no experience	Unsure how to answer	Total
Preschool	33,3%	52,9%	13,7%	100,0%
Primary school	56,8%	37,1%	6,1%	100,0%
Secondary school	60,2%	35,2%	4,6%	100,0%
Total	52,0%	40,4%	7,6%	100,0%

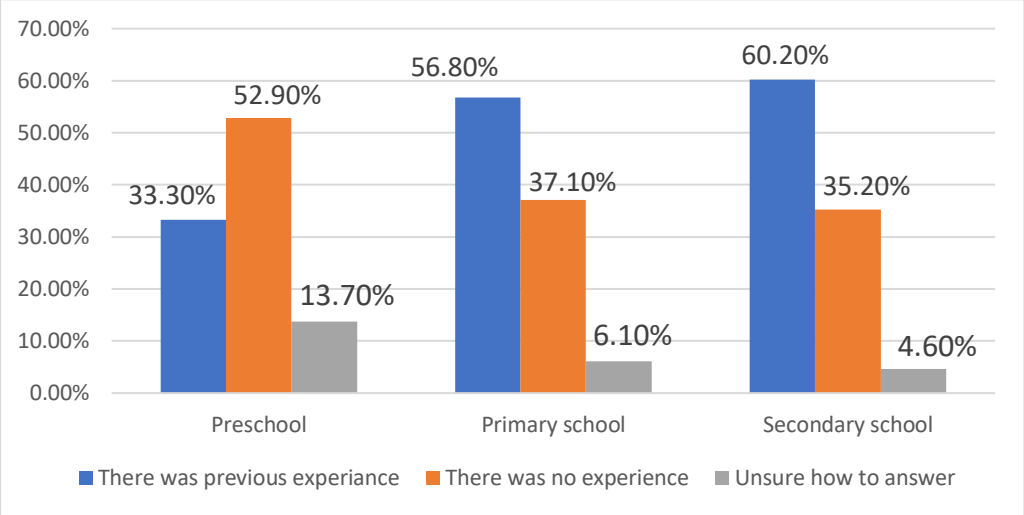


Fig. 28. Experience of using orthodontic appliances depending on the patient's age

52.0% of respondents report having experience with the use of orthodontic appliances (including preschoolers – 33.3%, younger school children – 56.8%, middle school children – 60.2%). This can be explained by several reasons. Firstly, it is important to mention the constant influence of etiotropic and accompanying factors. Secondly, the transformation of bite anomalies with the child's age, which is associated with jaw growth and the transition from primary to permanent teeth. In the "Literature Review" chapter, it was also mentioned that only a small portion of DFA tends to self-regulation.

The questionnaire question, "After consulting with the doctor, did you understand what problem you have with your bite and the consequences of not receiving treatment?" helped determine the awareness of the severity of their malocclusion problem and the treatment consequences based on the patient's age (Table 57).

Table 57. The awareness of their malocclusion problem and the consequences of not receiving treatment, depending on the patient's age, after consulting with the doctor

Age group	Awared	Not awared	Unsure how to answer	Total
Preschool	33,3%	50,0%	16,7%	100,0%
Primary school	46,0%	32,4%	21,6%	100,0%
Secondary school	40,7%	42,6%	16,7%	100,0%
Total	41,6%	39,2%	19,1%	100,0%

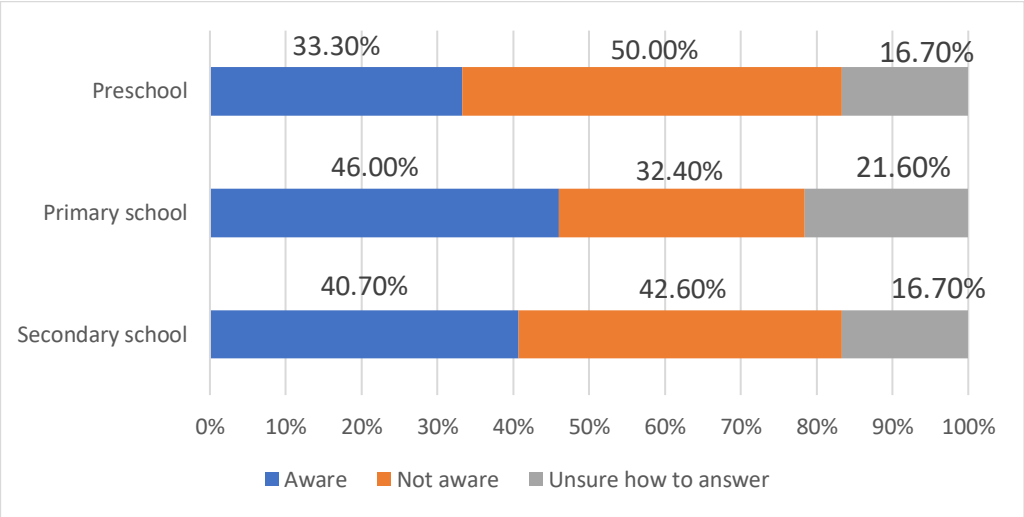


Fig. 29. The awareness of their malocclusion problem and the consequences of not receiving treatment, depending on the patient's age, after consulting with the doctor

The obtained data indicates that 41.6% of the respondents, after interacting with an orthodontist (through oral explanations, presentations with photographs, links to movies about DFA issues, and motivational work), became aware of their bite problem and the consequences of not seeking treatment (Table 57, Figure 29). Among them, preschoolers accounted for 33.3%, elementary school children for 46.0%, and middle school students for 40.7%. Therefore, a majority of the respondents have a positive attitude towards the recommendations provided by their orthodontist.

In the questionnaire, it was important to identify the respondents' readiness for orthodontic treatment, including compliance with the doctor's recommendations regarding appliance wear, bracket fixation, and oral hygiene maintenance (Table 58).

Table 58. Readiness for orthodontic treatment – appliance wear, following the doctor's recommendations

Answer options	Qty	Percent
Yes	297	70,2
No	86	20,3
Unsure how to answer	40	9,5
Total	423	100,0

70.2% of the respondents provided a positive response regarding their readiness to comply with the doctor's recommendations for wearing the orthodontic appliance,

bracket fixation, and maintaining oral hygiene (20.3% of the respondents gave a negative response) (Table 58). As a result of conversations with these respondents, it was revealed that they are afraid that nobody in their class or surroundings wears orthodontic appliances, and they fear communicative difficulties as a result of wearing them. Out of 86 individuals, 59 expressed this concern, while the remaining respondents (17 individuals) did not understand the essence of the doctor's conversation and assumed that they would have to wear appliances for their entire lives or at least continuously until the age of 18. Out of the total number of respondents, 132 boys and 164 girls of all ages have a positive attitude towards orthodontic treatment. This fact indicates that even at an early age, girls are more attentive to their appearance. It is informative to study the opinions of the group of respondents who have a negative attitude towards treatment. Out of 423 individuals, 86 (20.3%) have a negative attitude towards treatment, with 47 boys (11.1% of the total number of respondents) and 39 girls (9.21% of the total number of respondents).

After analyzing the responses to the questions posed to the respondents, the following conclusions can be drawn. Children from the selected patient group possess hygiene skills and oral care habits (62.6% brush their teeth twice a day). Upon closer examination, the female respondents show a higher level of dental health awareness (70.7% of girls). Respondents often visit dental doctors (54.0% of primary school students visit doctors once every six months). Most children in the group have experience with therapeutic manipulations, with the highest value observed among primary school students – 77.0% of children have experience with dental treatment. Moving on to assessing patients' knowledge of dental caries, we start by identifying predisposing factors for its occurrence in children. So we have learned that a significant portion of children have had some degree of nasal breathing problems associated with acute respiratory viral infections (ARVI), and a large number of children have heard remarks and warnings from parents and educators about incorrect posture. However, the respondents themselves often do not see any problem in this and do not perceive these factors as being related to overall health and proper occlusion. Most children have had experience with orthodontists – 57.7% of respondents have visited them at different

ages. Based on the survey data, 52.0% of children had some experience with wearing orthodontic appliances. The main focus of the conducted children's questionnaire is partially formulated at the beginning of the research text and clearly described in the chapter’s title "Malocclusion as an Important Medical and Social Problem." Therefore, in addition to medical factors, we were also interested in social factors, specifically the interpersonal relationships within the collective depending on the child's existing occlusion problems, their own opinion about the occlusal condition, and a range of socio-economic factors that were mentioned during the analysis of each question. Communication problems with peers exist in one-third of children (32.9%), which is a relatively high indicator. We have found that in such situations, children may not be fully socially adapted to their environment, which can lead to issues with academic performance in school and various other challenges [132].

4.3. The sanitary culture of parents of patients with dentofacial anomalies as an important motivating factor for orthodontic treatment

The attitude of parents and legal representatives towards orthodontic treatment plays a significant role in shaping the level of motivational attitudes of children towards such treatment.

As a result of the study, 411 respondents, residents of St. Petersburg and Tyumen, parents and legal representatives of children aged 6 to 14, were surveyed. Among them, 9.2% were parents of 6-year-old children, 9.0% were parents and legal representatives of 7-year-old children, 8.0% of 8-year-old children, 10.7% – of 9-year-old children, and 11.4% – of 10-year-old children. 14.1% were parents and representatives of 11-year-old children, 16.5% – of 12-year-old children, 11.7% – of 13-year-old children, and 9.2% – of 14-year-old children. Out of the 411 respondents, 72% were parents of children, 24.1% were close relatives (grandparents), 1.7% were legal guardians, and 2.2% were adoptive parents. Among them, 57.7% were parents and legal representatives of girls aged 6 to 14, and 42.3% were parents and legal representatives of boys aged 6 to 14. The questionnaire consisted of 32 questions (Appendix B).

The main method of collecting empirical data was a questionnaire survey, which was implemented through the "Google Forms" service. The link to participate in the

survey was provided to parents or other individuals accompanying child patients to the dental office, directly at the medical institution.

After the general introductory questions of the questionnaire, parents were asked the following question: "How often do you take your child to dental appointments?"

Table 59. The frequency of a child's visits to the dentist

Visits frequency	Qty	Percent
This is the first visit	32	7,8
Several times (irregularly, as needed)	153	37,2
We go regularly, at least once a year	171	41,6
We go quite often, as there is a need for treatment	51	12,4
Unsure how to answer	4	1,0
Total	411	100,0

41.6% of respondents answered that they accompany their child to the dentist "at least once a year". 51% responded that they go quite often, as they believe there is a need for systematic treatment for their child. However, 37.2% stated that they visit the dentist irregularly, "as needed" (Table 59). These data may indicate either a lack of understanding of the importance of systematic monitoring of children aged 6 to 14 by a dentist or specific financial constraints that prevent regular visits to the dentist.

The obtained data allow us to conclude that respondents have a limited awareness of the importance of systematic monitoring of children by a dentist. Another explanation for the observed distribution could be financial difficulties that hinder regular visits to the dentist. It is important to note that the frequency of dental visits is a significant indicator that characterizes the oral health status of children. The Ministry of Health of the Russian Federation recommends that children visit the dental clinic at least once every six months. The regularity of visits is a crucial condition for the timely detection of oral cavity diseases at early stages. In addition, dental visits are almost always associated with preventive work. Thus, children who regularly visit the dentist have a higher likelihood of maintaining dental and gum health. However, it is important to understand that the frequency of doctor visits is not a constant and may vary

depending on the child's individual characteristics." It is necessary to consider factors such as a child's dietary behavior, age, dental history, and overall health. In any case, it is important to establish comfortable psychological relationships with the dentist in order to maintain contact and develop oral hygiene habits.

Table 60. The goal of visiting a dentist with a child

Goal of visiting	Qty	Percent
Preventive examination	204	49,6
Specific dental problems that require resolution, such as acute pain, planned treatments, and consultations regarding the oral health condition	169	41,1
Correction of occlusal anomalies	27	6,6
Oral mucosal diseases	11	2,7
Total	411	100,0

When answering the question, 49.6% of respondents named the need for a preventive examination as the main reason for visiting a dentist, 41.1% of parents and representatives of the child noted the presence of a problem with teeth (acute pain or planned treatment, consultation on oral health) ; correction of occlusion abnormalities was named by 6.6% of respondents as the main reason for visiting the dentist; 2.7% – disease of the oral mucosa (Table 60).This result indicates a relatively high level of understanding among parents and legal representatives of the child regarding the necessity of preventive examinations with a dentist. This response correlates with several scientific studies and research on preventive dentistry [199, 150].

Table 61. The source of recommendations for visiting a dentist-orthodontist

Source of recommendations	Qty	Percent
Treating dentist	193	47,0
Paediatrician	80	19,5
Medical staff at school or kindergarten	8	1,9
Relatives or acquaintances	8	1,9
Independent decision (parental initiative)	111	27,0
Other healthcare professionals such as an otolaryngologist or speech therapist	11	2,7
Total	411	100,0

During the survey, parents were asked to indicate who recommended them to seek orthodontic treatment (Table 61). The results showed that 47% of children were referred to an orthodontist by a dentist, 19.5% by a paediatrician, 2.7% by healthcare professionals in related fields (such as an otolaryngologist or speech therapist), 27% based on parental initiative, 2.7% based on recommendations from relatives and acquaintances, and 1.9% were referred by medical staff at schools or kindergartens. According to the obtained data, there is no active collaboration between healthcare professionals in related fields and medical staff in schools and kindergartens in terms of interacting with parents for the treatment of DFA. However, the treatment of such patients is not solely within the competence of orthodontists in many cases. The examination of a child should be conducted in a systematic multidisciplinary manner, with the timely involvement of doctors from various specialities (paediatricians, neurologists, otolaryngologists, speech therapists, etc.), as we can infer from the various etiological factors described in the section "Etiology and Pathogenesis of Malocclusions".

Table 62. Reasons for seeking orthodontic treatment

Cause of visit	Qty	Percentage
Improper tooth positioning (crowding, rotations, etc.)	175	42,6
Correction of malocclusion	172	41,8
Nocturnal apnea (breathing disorders, snoring)	24	5,8
Incorrect swallowing, facial muscle atrophy (referred by a speech therapist)	18	4,4
Other	22	5,4
Total	411	100,0

- *Pain 1*
- *Consultation 2*
- *Planned sanitation after treatment completion 7*
- *Fillings 1*
- *Prevention 7*
- *Tooth wear 2*
- *Joint popping and clicking 2*

As a result of the survey, it was found that 42.6% of parents and legal guardians of the child sought orthodontic treatment due to complaints of improper tooth

positioning (crowding, rotations, etc.); 41.8% sought treatment for correcting malocclusion; 5.8% sought treatment for nocturnal apnea (breathing disorders, snoring); and 4.4% sought treatment for incorrect swallowing and facial muscle atrophy (referred by a speech therapist). Other reasons for seeking orthodontic treatment (5.4%) were reported as follows: "tooth wear" – 2 respondents, "prevention" – 7 individuals, "joint popping and clicking" – 2 individuals, and "consultation" – 2 individuals. Several respondents mentioned that their reasons for seeking orthodontic treatment were "tooth sanitation and examination after completion" – 7 individuals (Table 62). The obtained results indicate both the patients' understanding of the reasons and pathological processes for which it makes sense to seek help from a dental orthodontist, as well as the diverse clinical picture in the examined sample of patients. Because orthodontic treatment is quite expensive, it was important to determine the income level of the respondents.

Table 63. Parents' readiness for orthodontic treatment of their child

Answer options	Yes	No
Long-term treatment	91,7	8,3
Expensive treatment	25,5	74,5
Regular visits to the dental orthodontist (once every 1.5-2 months)	80,0	20,0
Visiting the dentist for preliminary oral sanitation	92,2	7,8
Possible visits to related specialists	75,4	24,6

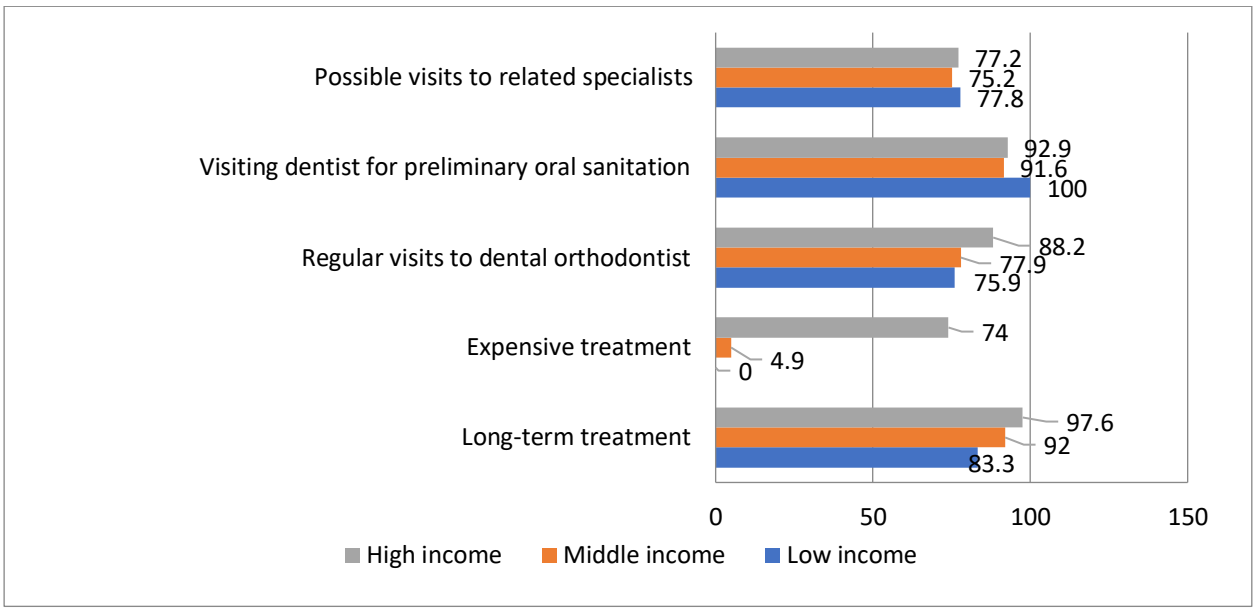


Fig. 30. Distribution of responses to the question regarding the readiness of respondents to face challenges during the treatment of dental conditions in children (%).

The results of the response to the question "Are you ready for orthodontic treatment for your child" (Table 63, Figure 30) yielded the following answers: 91.7% of parents are aware that orthodontic treatment is a lengthy process and express their readiness to accept it, 80% of parents are ready for regular visits to the dental orthodontist (once every 1.5-2 months); 92.2% of parents are aware of the necessity of visiting the dentist for preliminary oral sanitation. The majority of parents also recognize the importance of visiting related specialists (75.4%), which demonstrates their understanding of the complexity of the orthodontic treatment process and their awareness of the need to involve specialists from various fields (paediatricians, otolaryngologists, speech therapists, etc.) for successful treatment. However, while recognizing the necessity of orthodontic treatment for their child and being aware of the high cost associated with such treatment, 74.5% of respondents are not ready to pursue it for their children due to the price of orthodontic procedures and appliances. The readiness for orthodontic treatment for their child varies among groups with different levels of prosperity, as expected. The possibility of such expensive treatment is available among wealthy respondents only, which is why they demonstrate readiness more often (24.8% and 6.1%, respectively). Those with modest incomes often try to compensate for treatment through preventive measures, such as preliminary oral

sanitation. Thus, it can be concluded that there is an inequality in access to quality dental healthcare. These data are consistent with other studies in the field of sociology in medicine and dentistry, in particular [191, 196]. Based on the aforementioned results, it can be concluded that orthodontic treatment is not only an indicator of health care but also a marker of social well-being and prosperity in a family.

Table 64. Characteristics of the financial situation of the child's family

Characteristics of the financial situation of the child's family	Qty	Percent
Insufficient funds for everyday expenses	5	1,2
The entire salary goes towards everyday expenses	52	12,7
There is enough for everyday expenses, but purchasing clothing is difficult	99	24,1
Mainly enough, but borrowing is necessary for purchasing expensive items	128	31,1
Almost enough for everything, but acquiring an apartment or a country house is challenging	102	24,8
We hardly deny ourselves anything	25	6,1
Total	411	100,0

Based on the responses received, it can be seen that 1.2% of respondents indicate that even everyday expenses are challenging for their family, 12.7% of respondents mention that their entire salary goes towards everyday needs, 24.1% note that there is enough for everyday expenses, but purchasing clothing is difficult. In other words, 38% of respondents consider themselves to be low-income. 31.1% believe that in their families, there are mainly enough funds, but borrowing is necessary for purchasing expensive items (Table 64). Thus, 69.1% of the respondents consider their family to be insufficiently provided for. This figure is quite high, even though St. Petersburg and Tyumen are cities with a good quality of life.

Hygiene issues play a significant role in the prevention of dental diseases in children. The development of sanitary and hygienic skills should be differentiated based on the goals and content, depending on the patient's age. The primary form of such education involves periodic repetition and training. Moreover, a crucial role is attributed to the personal example of the parent or another influential socializing agent for the

child. In early childhood, with an appropriate approach, a hygienic skill can easily transform into a sustainable habit [199].

In our study, the question "Who taught your child how to take care of their teeth?" aims to identify the primary initiator of the formation of the child's hygienic habits.

Table 65. The distribution of responses to the question regarding who taught the child how to take care of teeth

Answer options	Qty	Percent
Self-taught (parents)	204	49,6
Grandparents	86	20,9
Older siblings (brother/sister)	33	8,0
Dentist during a preventive examination	65	15,8
Teacher/caretaker at kindergarten	14	3,4
No formal education was provided	3	0,7
Other	6	1,6
Total	411	100,0

Other:

- *Unsure how to answer 1*
- *Self-taught 3*
- *Paediatritian 2*

In the conducted study, parents were found to be the main contributors to the formation of hygienic skills (49.6%). 20% indicated that grandparents were responsible for teaching the child about dental care (20.9%), while 15.8% of respondents reported receiving hygiene advice from a dentist. Additionally, 8% mentioned that older siblings in the family played a role in organizing this process. In some cases (0.7%), respondents indicated that no formal education was provided, while 1.6% chose the option "other." Among those who selected "other," two respondents mentioned that the paediatrician provided the education, and three respondents stated that the child learned independently. One respondent was unsure and did not provide a specific answer. The survey results revealed that doctors in related specialities (paediatricians, speech therapists, otolaryngologists) who were visited by children did not place significant

emphasis on informing them about the importance of forming hygienic skills while performing their duties (Table 65).

During the survey, the question of respondents' awareness regarding additional oral hygiene products, apart from the "standard" toothpaste and toothbrush, was examined (Table 66).

Table 66. Assessment of knowledge (%) of oral hygiene products

Types of oral hygiene products	Qty	Percent
Medicated toothpaste	388	94,4
Dental floss	370	90,0
Rubber finger brushes	80	19,5
Irrigator	87	21,2

Other

- *Gels 60*
- *Interdental brushes 2*
- *Chewing gum 2*
- *Candies with xylitol 2*
- *Mouthwashes 36*

The analysis of respondents' answers revealed a lack of awareness regarding various oral hygiene products. Medicated toothpaste was identified as an important hygiene product by 94.4% of respondents, while many were familiar with and used dental floss in their oral care routine (90%). Only 21.2% recognized the irrigator as a necessary tool for oral care, and rubber finger brushes were noted by 19.5% of respondents. Approximately a quarter of the respondents provided their interpretation of the answer options. Among them, 58 individuals mentioned gels, 34 individuals mentioned mouthwashes, 2 individuals mentioned interdental brushes, 2 individuals mentioned chewing gum, and 2 individuals mentioned xylitol candies. The survey revealed insufficient awareness among respondents regarding various oral hygiene products, which may limit and complicate the proper selection of necessary hygiene aids. As demonstrated by several scientific studies, knowledge and skills related to oral hygiene correlate with an individual's social status and ability to maintain oral health [241, 236].

Dental education of the population is a crucial component of the oral cavity and DFA disease prevention programs. It should precede and be conducted in parallel with oral hygiene education. The key objective of educational initiatives is to foster personal responsibility and motivation for maintaining health by providing information and knowledge about the fundamentals of health-promoting behaviour and the principles of developing appropriate habits. In this regard, parents, who were respondents, were asked the following question: "Have you attended dental lectures in schools or kindergartens?"

Table 67. Attendance of lectures by dental professionals in schools and kindergardens

Answer options	Qty	Percent
Yes	86	20,9
No	235	57,2
Unsure how to answer	90	21,9
Total	411	100,0

According to the obtained research results, only 20.9% of the children of the respondents attended lectures by dental professionals in schools and kindergartens. 57.2% of parents and legal guardians responded negatively, while 21.9% of respondents were unsure how to answer (the reason for the negative response could be the lack of information about such an event taking place in the kindergarten or school).

It is also worth mentioning the association between the presence of harmful habits and the development of Dental Facial Anomalies (DFA). In Chapter 1, the research conducted by Carvalho et al. (Belgium, 1998) [162] highlights the high frequency of occlusal pathologies in children aged 3-5 years who have persistent harmful habits such as pacifier use and thumb-sucking. Russian researchers, acknowledging the significant role of harmful habits in the occurrence of dental anomalies and deformities, identify three groups of harmful habits in particular:

- finger-sucking and biting, lip and cheek biting, and chewing on foreign objects;

- functional anomalies – disturbances in chewing function, mouth breathing, improper articulation, etc.;

- fixed postures that determine incorrect positioning of the lower jaw and tongue [37].

The negative effects of harmful habits can manifest in the development of lower jaw displacement, misalignment of teeth, alteration of dental arch shape, and bite abnormalities. These changes can become more pronounced with age and contribute to facial asymmetry, temporomandibular joint disorders, posture issues, and so on. In orthodontics, the elimination of harmful habits is an important component in correcting the bite. However, the challenge lies in their automatic and involuntary nature [37]. Persuasion factors often prove to be ineffective, and there are no universal methods for their elimination.

Table 68. Conducting discussions on the prevention of pathological bite in children by various specialists

Specialist	Yes (%)	No (%)
Nurse, paramedic	48,9	51,1
Dentist	94,2	5,8
Teacher (educator in a kindergarten)	1,5	98,5
Pediatrician	38,7	61,3

As a result of the survey, 94.2% of respondents noted that the discussions and lectures were conducted by a dentist, while 48.9% indicated that the lectures were given by a local nurse or paramedic (with 51.1% giving a negative response). Furthermore, 38.7% identified a paediatrician as the primary source of information on bite prevention issues (with 61.3% giving a negative response). The obtained data indicates the existence of a certain readiness within the medical community to implement a comprehensive approach to the prevention and treatment of DFA.

Table 69. Presence of harmful habits in a child

Harmful habits	Qty	Percent
Thumb or finger sucking	52	12,7
Biting on hands, pencils	269	65,5
Incorrect tongue position during swallowing of liquid food (tongue between upper and lower incisors)	36	8,8
The child breathes through the mouth	163	39,7
Nighttime snoring	92	22,4
Hunching while walking and sitting	200	48,7

65.5% of respondents indicated that the child bites on hands and pencils; 39.7% mentioned that the child predominantly breathes through the mouth, which is also considered a harmful habit in the absence of pathological changes in the nasopharynx or after its sanitation; 22.4% reported observing nighttime snoring in their child. Incorrect tongue position during swallowing of liquid food (tongue between upper and lower incisors) was noted by 8.8% (Table 69). Eliminating harmful habits in orthodontics is an important component in correcting malocclusion. However, the difficulty in combating these habits lies in their automatic and involuntary nature (Distel, Suntsov, 1991). Persuasive factors often prove to be ineffective, and there are no universal methods for their elimination. Addressing harmful habits requires tremendous attention to the child, patience, as well as awareness of the consequences of their influence.

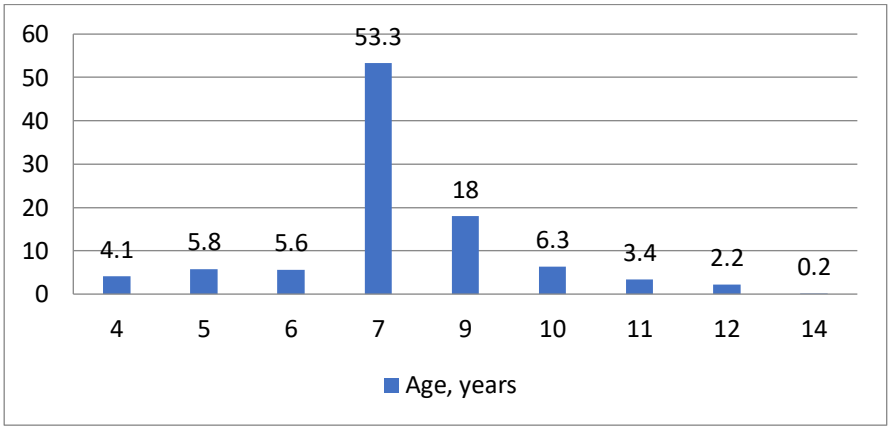


Fig. 31. Prevalence of bite problems in children according to age (as reported by parents) (%)

53.3% of parents noticed bite problems in children at the age of 7, while 18% noticed them at the age of 9 (Figure 31). This can be attributed to several reasons – at the age of six, children undergo the process of physiological tooth replacement, specifically the eruption of their first incisors and first molars. This, combined with bone growth activation, can serve as a trigger for the appearance of DFA. At the age of 9, the eruption of second incisors and first premolars occurs, and if their growth is incorrect, parents also start paying attention to their child's bite.

Table 70. Observation of the child by an ENT specialist

Answer options	Qty	Percent
Yes	254	61,8
No	157	38,2
Total	411	100,0

Complex malocclusions associated with impaired nasal breathing during sleep are a factor that can trigger ENT diseases. This is confirmed by the results of our survey: the majority of child patients are currently or have been observed by an ENT specialist (61.8%). Chronic inflammation of the nasopharynx and paranasal sinuses often necessitates the use of antibiotics during exacerbations. However, not every doctor can accurately establish a connection with malocclusion.

Combined Table 71. The correlation between visiting an otolaryngologist and the onset of bite abnormalities (child's age) (%)

		At what age did you (or your child) start noticing problems with the bite?									Total
Is your child being observed by an otolaryngo-logist?		4	5	6	7	9	10	11	12	14	
	Yes	10	15	19	130	41	16	12	7	1	251
		58,8%	62,5%	82,6%	59,4%	55,4%	61,5%	85,7%	77,8%	100,0%	61,7%
	No	7	9	4	89	33	10	2	2	0	156
		41,2%	37,5%	17,4%	40,6%	44,6%	38,5%	14,3%	22,2%	0,0%	38,3%
	Total	17	24	23	219	74	26	14	9	1	407
		100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

The correlation between respiratory system diseases and DFA was also examined in terms of the frequency of observations by an otolaryngologist among children of

different age groups with identified bite abnormalities (Combined Table 71). A higher incidence of ENT pathology coinciding with malocclusion was observed in children at the age of 6 (82.6%) and 11 (85.7%) years. In the remaining age groups, the frequency of coincidences is also quite high (on average 61.7%), which correlates with the data described in the "Literature Review" chapter and demonstrates the interrelationship between these two phenomena.

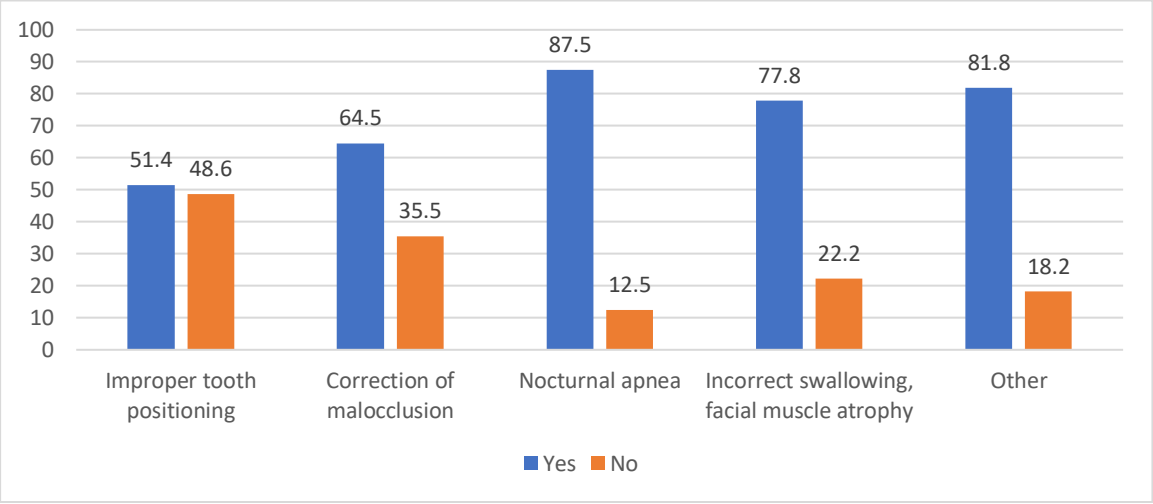


Fig. 32. The correlation between visiting an otolaryngologist and the reason for seeking orthodontic dental care (type of anomalies) (%)

As a result of data analysis (Figure 32), it was found that the majority of children aged 6 to 14 years who were under the care of an otolaryngologist (254 children out of the surveyed) actively visited a dentist (61.8%). 157 parents responded negatively to the question "Is your child being observed by an ENT specialist?". Furthermore, during the analysis of the conducted study, a comparison of data on the frequency of visits to a dentist and an otolaryngologist was carried out [132]. The following data were obtained as a result: children with a pronounced need for dental treatment, who frequently visit a pediatrician, also often undergo therapeutic procedures during visits to an otolaryngologist (86.3%). In the case of visiting a dentist as needed, the frequency of referrals for nasopharyngeal problems decreases to 55.6%. The average frequency of coincidences in the sample is 61.8%.

4.4. Justification for the development and implementation of a program for the prevention of dentofacial anomalies

During the study, a large number of children suffering from dentofacial anomalies (56.8% in Tyumen and 63.72% in St. Petersburg) (Table 8, Table 14) were found to not undergo orthodontic treatment (therapeutic measures are carried out in 23.3% of children in Tyumen and 35.2% in St. Petersburg). Conversations with patients revealed a group of children who are committed to oral care (62.6%), regularly scheduled visits to the dentist for check-ups (45.4%), and regular treatment or hygiene procedures (67.1%). On the other hand, conducting mass screenings and sociological research has revealed a significant number of children and parents who, to varying degrees, neglect oral health. As mentioned earlier, only 27% of parents are aware of the problem of dentofacial anomalies in their child and have independently decided to visit an orthodontic dentist. The primary reason for this is the insufficient level of health promotion in kindergartens and schools. Only 20.9% of parents attended events involving dentists in educational institutions (lectures, class hours, parent meetings, etc.) (Table 67), which is an important factor given that school serves as a vital link between the child and the family, playing a role in the socialization of children in society. Previously, a connection between social factors and the impact of dental caries on children and adolescents was observed. Difficulties in communicating with friends due to dental issues, remarks from peers, and challenges in establishing relationships with their environment can all, to some extent, traumatize the mental well-being of the child or adolescent and leave an imprint on their future socialization and oral health.

All of this necessitates addressing the issue of developing a program for the prevention of occlusion anomalies, which should be multifactorial and multi-stage. It should involve not only medical personnel but also kindergarten and school education workers, with mandatory involvement of the child's parents in the process.

CONCLUSIONS

1. It was discovered that DFA was present in 56.8% of the examinees in Tyumen and 63.8% in St. Petersburg. Sexual dimorphism in the city of Tyumen: females make up 52.9%, in the city of St. Petersburg – 52%, males, respectively, 47.1% in Tyumen and 48% in St. Petersburg. The prevalence of malocclusion in the city of Tyumen among girls 6-14 years old, occlusion anomalies were noted in 46.8%, among boys – 53.2%, in the city of St. Petersburg, the prevalence of DFA in girls is 40.65%, in boys – 59.35 %. Occlusion anomalies manifest themselves most clearly in preschool and primary school age in both settlements under consideration - in the city of Tyumen, frequency of malocclusions in this age group - 84.94%; in St. Petersburg – 83.2%.

2. It has been established that there are currently no specialized prophylaxis programs of malocclusions on the territory of the Russian Federation. Most of the existing programs are aimed at solving problems associated with the high prevalence of caries among children and the early loss of temporary and permanent teeth. The reasons for the lack of a prevention program only for children with malocclusion and the consequences of the formed pathology on the body and alleviation of the consequences of the influence of the formed anomaly on the child's body are:

-multifactorial and polyetiologism of occurrence;

-the need for a global approach to solving this problem;

- high cost of implementation;

-active work with all layers of society.

3. It has been determined that the index assessment of individual patients or whole groups makes it possible to assess the severity and course of the disease on both individual and population levels. Summing up the calculations of patients examined in Tyumen and St. Petersburg got us the following results: the final coefficient was 31.34 in St. Petersburg, and 34.27 in Tyumen, and both results suggest a moderate severity of the pathological process.

4. The data identified during the sociological monitoring of parents, children and orthodontists showed that the majority of parents brought their children for examination to an orthodontist either on the recommendation of the attending dentist-therapist or

pediatric dentist (47%), or it was their independent decision (27%). 42.6% of parents brought their children to solve a problem with the position of individual teeth, while 41.8% – for consultation on the treatment of malocclusion, which indicates the understanding of the surveyed people of the range of problems solved during orthodontic treatment. 91.7% of parents showed readiness for long-term treatment; 25.5% of respondents were ready for expensive treatment.

Children are aware of their problems with bite of 41.6% of respondents and readiness to begin orthodontic treatment was expressed by 70.2% of children, which indicates that children understand to varying degrees their condition of the maxillofacial area and desire to correct it, regardless of the opinion of their parents.

45.0% of dentists participated in mass preventive examinations of children in preschool and school institutions. Clinicians, during a further survey, pointed out the importance of preventive control of malocclusions, especially under the age of 6 years (62.5%). 72.5% of respondents recognized the advisability of introducing a program for the prevention of malocclusions, which can be explained by the lack of generally accepted algorithms for prevention and treatment in doctor’s practice -orthodontist, and the lack of a unified etiological concept of bite pathologies and the multifactorial nature of the causes leading to their occurrence [132].

5. When considering each individual etiological factor, it was determined that in the experimental group of subjects, the number of children suffering from factors of concomitant dentofacial anomalies significantly decreased; a decrease was also noted in the control group of children, but it was not so pronounced; the need for the development and implementation of programs was determined prevention for children with malocclusion, with the involvement of orthodontists and doctors of related fields to more effectively solve the problems of prevention and correction of malocclusions.

SUMMARY

Prevention of malocclusion in modern dental practice is a cornerstone problem and an urgent task of clinical orthodontics. Dental anomalies are one of the most common groups of oral diseases after caries, with a tendency to constantly increase the number of patients. Malocclusion is a multifactorial pathological process characterized by a number of causes of occurrence and development [126]. The chapter “Literature Review” highlighted the problem of the high prevalence of DFA among children of various age groups, social and ethnic groups. As an analysis of domestic and foreign literature has shown, malocclusions do not tend to decrease and do not show clear age and gender differentiation. The high incidence of CCA is primarily associated with odontogenic factors, namely advanced forms of caries, leading to premature loss of primary and permanent teeth. It is worth noting an interesting trend: some researchers associate the odontogenic nature of pathological occlusion with social factors – inaccessibility of dental care, insufficient level of promotion of oral health, etc. The next factor worthy of attention is the dysfunction of nasal breathing and, as a result, the development of compensatory forms of breathing, which leads both to changes in the morphology and structure of the hard and soft tissues of the maxillofacial area, and to problems associated with changes in the tone of the facial muscles and a decrease in chewing activity. Domestic researchers noted a connection between mouth breathing and underdevelopment of the upper jaw in respondents. This process was accompanied by a narrowing of the maxillary bone and a change in the shape of the hard palate, a change in the child’s facial features (adenoid type), and a decrease in the vital capacity of the lungs due to the physiology of the respiratory tract. Incorrect posture is also a trigger for the development of occlusion pathology. The problem of the connection between bite and posture is very interesting, although it does not have a clear evidence base. However, in vivo studies confirm the relationship between the position of the cervical vertebrae and the height of the bite, which causes both malocclusion and the development of a number of neurological processes.

During the writing of the dissertation “Clinical and diagnostic foundations of dental care in the system of a comprehensive program for the prevention of

maxillofacial anomalies in children," a clinical and sociological study was conducted. The bases were the Regional Hospital No. 19 of Tyumen and the City Children's Dental Clinic No. 6 of St. Petersburg. The subjects of the clinical study were 1874 children and adolescents aged 6–14 years, their parents or legal representatives and treating doctors were selected as objects of sociological research.

The clinical study can be conditionally divided into several parts – firstly, a clinical examination of children, the purpose of which was to identify the orthodontic status of the child, and secondly, the study itself, which revealed the relationship between relapses and etiological factors influencing the development of malocclusions. The sociological study consisted of surveys of orthodontists, children undergoing clinical examinations and their parents.

During the first stage of the clinical study, 1874 children from three age groups were examined. In Tyumen, 967 respondents were examined, among whom 549 (56.8%) cases of malocclusion were identified; 128 children (23.3%) were undergoing orthodontic treatment at the time of the study. In St. Petersburg, a clinical examination was carried out among 907 children, 578 cases of DFA were identified (63.8%), 204 children (35.2%) were treated. Gender dimorphism of malocclusions is not clearly expressed and looks like this: in the city of Tyumen, out of the total mass of those examined, 52.9% were girls; problems with bite occurred in 46.8%. In boys, 53.2% have malocclusions. In St. Petersburg, among the respondents, 52% were girls and 48% were boys, respectively. Malocclusion among female respondents is 40.65%, and among boys – 59.35%. Speaking about the age-related manifestations of DFA in children, the following conclusions can be drawn: the greatest prevalence of the anomaly is observed among the preschool and primary school group of children in Tyumen – 83.2% (84 studied) in children 8 years of age, and in St. Petersburg 84.9% (79 examined) among 6-year-old children). As we see from the first part of the clinical study, the general picture of the distribution of occlusion anomalies is generally identical in studied regions and correlates with the high prevalence of DFA both in Russia and in other countries and regions, judging by the analysis of scientific literature carried out in the 'Literature Review' chapter.

Next, an analysis of the examined group of children and adolescents was carried out using the ICON index. The principle of operation and application of the index are described in the chapters “Anomalies of bite as an important medical and social problem” and “General design of the study: materials and methods, research base, instruments.” The ICON index is multi-component and therefore, to correctly calculate each index item, the formula [133] was used:

$$(\sum x + y + z) \div Nt \div R,$$

where x+y+z is the sum of the obtained indicators for three age groups, Nt is the number of respondents participating in the study, the R-coefficient is individual for each component of the index. Thus, as a result of the calculation, it is possible to obtain the average value for each component of the index for a large population.

So, a similar calculation was carried out among subjects from two cities for each component of the index – the aesthetic component, the presence or absence of cross closure, the presence or absence of open and deep bite and the nature of fissure-tubercle contacts.

The final values of the ICON index for the two cities under study are the following: in Tyumen the index coefficient is 34.27, and in St. Petersburg it is 31.34.

The next stage of the clinical study was a comparison of two groups of patients (experimental and control), among which methods for correcting concomitant pathologies were introduced together with the ongoing orthodontic treatment (the research methodology is described in the chapter “Own research.” Two equal groups of children were formed without taking into account age, gender and geographic differences (place of residence), since it was proven that these factors did not influence the level of distribution and nature of malocclusion. 121 children were selected into the control group, and 118 children into the experimental group. The same orthodontic treatment methods were used in the experimental group as in the control group group, but additional medical manipulations and examinations from related specialists were involved. Correction of incorrect posture, mouth breathing, and planned sanitation were mandatory. In the control group, these activities were more of a recommendatory nature. The main emphasis during the study was on the stability of the treatment,

improvement in both dental and general status. Therefore, considering the results of the study, we came up with the following outlook: a decrease in the number of associated anomalies associated with malocclusion in both groups. The prevalence of sleep apnea decreased in the control group from 26.4% to 19%, in the experimental group – from 22% to 14.4%, mouth breathing decreased from 19.8% to 17.3% and from 16.1% to 9. 32% respectively. This is most clearly observed in children with the 2nd class of closure – in the experimental group, a decrease in the manifestation of mouth breathing in children with the 1st subclass of closure from 6.7% to 3.39%, in the control group from 5.8% to 4.96 %. In children with the 2nd subclass in the control group, there is a slight increase in manifestations from 7.4% to 7.44%. The pattern of distribution of mouth breathing in children with protrusion of the lower jaw practically does not change; in the control group there is also a slight increase from 4.9% to 4.96%. Considering children with postural pathologies, we can also note a picture of a noticeable decrease in manifestations in the experimental group: manifestations of kyphosis decreased from 16.95% to 11.02%, in the control group from 18.18% to 16.53%. The picture of lordosis decreased from 13.56% to 9.32% in the experimental group and from 15.7% to 10.74% in the control group. Manifestations of scoliosis also decreased in the experimental group from 18.64% to 14.41%, and in the control group from 19.01% to 15.7%. The changes are most clearly visible in children with class II jaw closure? with the 1st subclass of closure in the experimental group, there was a noticeable decrease in the manifestation of scoliosis from 9.32% to 7.63%. When considering patients with anomalies of soft tissue cords, the most clearly visible picture is associated with malocclusions with neutral closure of the jaws – in the experimental group, the frequency of anomalies associated with shortening of the frenulum decreases from 13.56% to 4.24% with unchanged indicators in the control group of patients (12, 4%). We also analyzed changes in the frequency of anomalies associated with early removal; changes in the experimental group are also clearly manifested with anomalies with neutral closure of teeth – from 10.17% to 4.24%, in the control group from 6.61% to 0. 83% for early tooth loss. In the case of violation of the timing of eruption from 23.73% to 7.63% in the experimental group, and from 21.49% to 13.22% in the control group.

This process is also clearly manifested in the group with anomalies in the second class of closure – in the first subclass, a decrease from 11.86% to 2.54% in the experimental group and an increase from 12.4% to 14.05% in the control groups, in the second subclass from 12.71% to 5.08% in the experimental group and from 14.05 to 8.26% in the control group.

Separately, it is worth mentioning the frequency of relapses after treatment, so in the experimental group we see a lower percentage of relapses associated with the mode of wearing the device – 8.47%, in the control group – 17.36%, with breakdowns of retention devices – in the experimental group – 5.93 % in the control group – 10.74%. Considering the groups of relapses associated with breathing abnormalities, posture and position of the lingual muscle and soft tissue cords, the difference between the two groups ranges from 1-4%.

To summarize, we came to the following conclusion. During identical medical procedures in two selected groups of patients, we observed the most positive dynamics of the retention period among children who underwent prevention and correction of concomitant pathology. Based on this, we see the prerequisites for the creation and implementation of a DFA prophylaxis program focusing not only and not so much on the DFA itself, but also pathologies of the respiratory system and musculoskeletal system. With timely correction of these accompanying processes, a positive effect affects not only the state of occlusion, but also the general somatic health of a person.

PRACTICAL RECOMMENDATIONS

1. When planning orthodontic treatment and during diagnostics, it is necessary to perform a comprehensive x-ray examination, including a CT in natural occlusion with a resolution of 17*15 mm, a TRG in lateral projection with beam centering on the projection area of the TMJ, as well as to take impressions for subsequent casting of plaster models (IV class) and maintaining a photo protocol to monitor treatment.
2. If there are pronounced signs of postural abnormality, preliminary correction of posture is recommended.
3. In case of pronounced mouth breathing, radiological signs of sinusitis or frequent acute respiratory viral infections in the life history, an otorhinolarynologist treatment is necessary.
4. During preparation for orthodontic treatment, sanitation of the oral cavity is required by applying fluoride-containing solutions to the enamel.

LIST OF ABBREVIATIONS

TMJ – temporomandibular joint

CT – computer tomography

WHO – World Health Organization

GAUZ – state autonomous healthcare institution

GBUZ – state budgetary healthcare institution

DFA – dentofacial anomaly

OPTG – orthopantomogram

TRG – teleroentgenogram

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APPENDIX

Appendix A

Current state of prevention and treatment of bite anomalies

Dear Colleagues! To further improve the quality of dental care and improve the methods of diagnosis and treatment of malocclusions, we invite you to fill out this questionnaire containing information about the main stages of managing patients with the above forms of pathologies in order to objectively assess the methods of prevention, diagnosis and treatment used.

1. **What is your working experience?**

   Отметьте только один овал.

   - ◯ 1-5 years
   - ◯ 5-10 years
   - ◯ 10-20 years
   - ◯ more than 20 years

2. **Do you more than one dental specialization (dental orthodontist)?**

   Отметьте только один овал.

   - ◯ I have just one specialization
   - ◯ I have two or more specializations

3. **What time ago did you undergo last advanced training (CME/scheduled periodic)?**

   Отметьте только один овал.

   - ◯ Less than a year ago
   - ◯ 1-4 years ago
   - ◯ 4-5 years ago

4. **How often do you attend courses/master classes in "Orthodontics" specialty?**

Отметьте только один овал.

- ◯ 1-2 times every 6 months
- ◯ 1-2 times a year
- ◯ once a year or less
- ◯ difficult to answer

5. **Do you take master classes in only one specialty or are you trying to gain new knowledge and skills in other dental areas?**

Отметьте только один овал.

- ◯ Only take courses in orthodontics
- ◯ Take courses in other specializations besides orthodontics
- ◯ Другое: _____

6. **What types of bite pathology do you encounter in routine clinical practice and how often:**

Отметьте только один овал в каждом ряду.

	Very frequently (almost on a weekly basis)	Unfrequently (once or twice a month)	Isolated cases	Virtually never encountered
Various types of teeth crowding	◯	◯	◯	◯
Deep incisal overlap	◯	◯	◯	◯
Distal occlusion	◯	◯	◯	◯
Mesial bite	◯	◯	◯	◯
Crossbite in one or more segments	◯	◯	◯	◯

7. **What is the severity level of this pathology you encounter the most in your practice?**

Отметьте только один овал в каждом ряду.

	Mild	Moderate	Severe	Difficult to answer
Various types of teeth crowding	◯	◯	◯	◯
Deep incisal overlap	◯	◯	◯	◯
Distal occlusion	◯	◯	◯	◯
Mesial bite	◯	◯	◯	◯
Crossbite in one or more segments	◯	◯	◯	◯

8. **At what stage of patient admission do you fill out an outpatient card? (multiple possible answers)**

Отметьте все подходящие варианты.

- [ ] I always start my appointment by filling out a card
- [ ] I fill out the card during an appointment
- [ ] I fill out the card during treatment
- [ ] I fill out the card after the treatment

9. **What data are you most interested in when collecting anamnesis in patients with malocclusion (choose all options that are important to you)?**

Отметьте все подходящие варианты.

- [ ] The patient's complaints at the time of examination, their characteristics
- [ ] The anamnesis of the present disease (onset, causes, development of the disease, dynamics)
- [ ] The anamnesis of the development of the dental system
- [ ] The presence of bad habits
- [ ] The past and concomitant diseases (ENT organs, endocrine diseases, etc.)
- [ ] The heredity
- [ ] Previous orthodontic treatment, if any

10. **When collecting anamnesis, what parameters do you pay attention to?**

Отметьте только один овал в каждом ряду.

	Always consider important	Sometimes consider important	Mostly do not consider important
chewing and facial muscles' tonus	◯	◯	◯
position, attachment and tonus of the lingual muscle	◯	◯	◯
tonus and condition of the neck muscles	◯	◯	◯
tonus and condition of the muscles of the shoulder girdle (posture)	◯	◯	◯
inspection and auscultation of the TMJ	◯	◯	◯

11. Which of the following diagnostic methods do you rely on while planning orthodontic treatment cases?

Отметьте только один овал в каждом ряду.

	Always	Sometimes (rarely)	Never
collection of life and illness anamnesi	◯	◯	◯
panoramic radiographic examination	◯	◯	◯
teleroentgenogram (in various projections)	◯	◯	◯
CT scan	◯	◯	◯
photologging	◯	◯	◯
assessment of the function of the TMJ and masticatory muscles	◯	◯	◯

12. **Do you use specialized software to calculate teleroentgenograms (in different projections)?**
(if yes, please indicate which)

Отметьте только один овал.

- ◯ Manual analysis
- ◯ MaveCloud and other cloud services
- ◯ Dolphin Imaging
- ◯ Kavo Imaging InVivo

13. **Do you use digital techniques for anthropometric calculations of dentition parameters or do you use plaster models? (multiple answers possible)**

Отметьте все подходящие варианты.

- [ ] I use CT for anthropometric calculations
- [ ] I use digital models of dentition in practice
- [ ] I use only analog diagnostic methods: plaster models, printouts of images

14. **Do you use removable appliances in orthodontic treatment? (multiple answers possible)**

Отметьте все подходящие варианты.

- [ ] single-jaw mechanical devices
- [ ] bimaxillary functional devices
- [ ] combined action devices
- [ ] extraoral devices
- [ ] LM-activators and trainers

15. **Do you use permanent fixation appliances in orthodontic treatment? (multiple answers possible)**

Отметьте все подходящие варианты.

- [ ] classic ligature bracket systems
- [ ] self-ligating bracket systems (active and passive)
- [ ] partial braces
- [ ] non-removable mechanical devices (Marco Rosa device, etc.)
- [ ] non-removable functional devices (Herbst apparatus, etc.)

16. **Do you know about specialized orthodontic prophylaxis programs conducted in the Russian Federation?**

Отметьте только один овал.

- ◯ Yes
- ◯ No

17. **Please choose which preventive activities you took part in (if you could recall)?**

Отметьте все подходящие варианты.

- [ ] mass examinations in kindergartens/schools (examination of children of various ages, identification of malocclusions, factors contributing to their further development and/or aggravation, supernumerary teeth, previously lost temporary ones, etc.)
- [ ] joint appointment of children with prerequisites for the development of malocclusions with specialists of related profiles (oral and maxillofacial surgeons, pediatric dentists, ENT doctors, speech therapists)
- [ ] sanitation of the oral cavity in pregnant women
- [ ] consultations with pregnant women planning to have a child (detection of the presence of malocclusions in parents and close relatives, congenital pathologies of the maxillofacial area)

18. **In your clinical practice, how often do you have to refer a patient to related specialists, including non-dental specialists?**

Отметьте только один овал в каждом ряду.

	Very frequently (virtually on a weekly basis))	Not frequently	In isolated cases	Virtually never
Dentists, including dental hygienists	◯	◯	◯	◯
Otorhinolaryngologist	◯	◯	◯	◯
Speech therapist	◯	◯	◯	◯
Pediatrician	◯	◯	◯	◯
Chiropractor/Osteopath	◯	◯	◯	◯
Maxillofacial surgeons	◯	◯	◯	◯

19. **Do you consider it necessary to talk about the malocclusions prophylaxis with future parents during a pregnancy planning?**

Отметьте только один овал.

- ◯ Yes
- ◯ No

20. **At what age do you think a child should start visiting an orthodontist for preventive examinations?**

Отметьте только один овал.

- ◯ 0-1 years old
- ◯ 1-6 years old
- ◯ 6-12 years old
- ◯ 12 years old and older

21. **Do you consider creating and implementing a prophylaxis program for malocclusions advisable?**

Отметьте только один овал.

- ◯ Yes
- ◯ No

Appendix B

Parents' questionnaire

*Обязательный вопрос

1. **Child's age (full years) ***

_____

2. **Child's gender ***

Отметьте только один овал.

- ◯ Female
- ◯ Male

3. **How often do you take your child to the dentists' office? ***

Отметьте только один овал.

- ◯ This is the first visit
- ◯ A few times (not regularily, only when issues occur)
- ◯ Regular visits, at least once a year
- ◯ Frequent visits due to the dental health issues
- ◯ Difficult ot answer

4. **What is the regular goal of visit? ***

Отметьте только один овал.

- ◯ Routing examination
- ◯ Teeth problems (acute pain, planned dental treatment, check on oral cavity health)
- ◯ Maloccluision anomaly treatment
- ◯ Oral mucosa diseases
- ◯ Other

5. **Who recommended taking your child to the orthodontist?** *

Отметьте только один овал.

- ◯ A dentist
- ◯ A pediatrician
- ◯ Medical staff in kindergarten/school
- ◯ A caregiver/teacher
- ◯ Relatives/friends
- ◯ Visit was an own decision
- ◯ Other

6. **What was the reason for the visit?** *

Отметьте только один овал.

- ◯ Teeth misalignment (crowding, rotation, etc.)
- ◯ Bite correction
- ◯ Night apnea (respiratory failure, snoring)
- ◯ Improper swallowing, facial atrophy (directed by speech therapist)
- ◯ Other

7. **Are you ready for orthodontic treatment for your child?** *

Отметьте только один овал в каждом ряду.

	Yes	Np
Long-term treatment	◯	◯
Costly treatment	◯	◯
Regular visits to the orthodontist	◯	◯
Visits to a dentist for oral sanation	◯	◯
Possible requirement to visit related specialists	◯	◯

Below are a few questions about the prenatal and postnatal health of your child, the answers to which will help you make a correct diagnosis, draw up a treatment plan, prevent complications of the current abnormal process and avoid the development of relapses.

8. **Was the pregnancy planned (considering this child)?**

Отметьте только один овал.

◯ Yes
◯ No

9. **Have you had regular prenatal check-ups?**

Отметьте только один овал.

◯ Yes
◯ No

10. **Was the birth on time?**

Отметьте только один овал.

- Yes
- No

If not, please elaborate

11. **On what week of pregnancy was the baby born?**

12. **Birth weight of a child**

13. **Did the child have a tooth change on time (if not, on what month did it occur):** *

Отметьте только один овал.

- Yes, it was timely
- Other

14. **Did you visit a child dentist after teething?** *

Отметьте только один овал.

- Yes
- No

15. **Who trained your child in dental care?** *

Отметьте только один овал.

- ◯ Parents
- ◯ Grandparents
- ◯ Older siblings
- ◯ A dentist during a routine visit
- ◯ A caregiver/teacher
- ◯ Child was not taught
- ◯ Other

16. **What supplemental oral care options are you aware of? (multiple possible answers)** *

Отметьте все подходящие варианты.

- ☐ Medical toothpaste
- ☐ Dental floss
- ☐ Rubber brush
- ☐ Irrigator
- ☐ Other

17. **Has there been an X-ray monitoring during and after the teething?** *

Отметьте только один овал.

- ◯ Yes
- ◯ No

18. **Does your child have (or have previously had) any bad habits ? If yes, which ones? (multiple possible answers)** *

Отметьте все подходящие варианты.

- [ ] thumb or index finger sucking
- [ ] gnawing of writing utensils
- [ ] improper position of the tongue when swallowing liquids (tongue between upper and lower incisors)
- [ ] mouth breathing
- [ ] night snoring
- [ ] slouching while walking and sitting

19. **Has your child been/is being observed by a doctor of ENT profile?** *

Отметьте только один овал.

- ◯ Yes
- ◯ No

20. **How would you describe your child's general health?** *

Отметьте только один овал.

- ◯ Mostly healthy
- ◯ Frequently ill
- ◯ Has a chronic disease
- ◯ Has a disability

21. **If a child has a disability, please elaborate**

_____

22. **At what age did you (or your child) begin to notice bite problems?** *

Отметьте только один овал.

- ◯ 7 years
- ◯ 9 years
- ◯ 10 years
- ◯ 11 - 12 years

23. **If your child had early removal of baby (temporary) teeth, what was the reason?** *

Отметьте только один овал.

- ◯ complication of caries
- ◯ trauma
- ◯ unstable teeth
- ◯ other

24. Does your child intake natural and rough food? *

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult ot answer

25. **Does your child eat fish, dairy products, fruits, vegetables?** *

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

26. **Have you attended dental lectures in schools, kindergartens?** *

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

27. **Have you ever had a talk about the prophylaxis of your child's pathologic bite? If yes, who did you talk to?** *

Отметьте только один овал в каждом ряду.

	Да	Нет
A nurse/ a paramedic	◯	◯
A dentist	◯	◯
A teacher	◯	◯
A pediatrician	◯	◯

We would like to ask you more about you and your family

28. **Where do you live?** *

Отметьте только один овал.

- ◯ Rural area (village, small town)
- ◯ Urban area (city)

29. Enter the name of a settlement you live in

_____

30. **What is your relation to the child?** *

Отметьте только один овал.

- A parent
- A close relative (grandparent, sibling ...)
- A guardian
- A foster parent

31. **Your age** *

32. **Your gender** *

Отметьте только один овал.

- Male
- Female

Appendix C

Patients' questionnaire

1. What is your gender?

   Отметьте только один овал.

   - ◯ Female
   - ◯ Male

2. **How old are you?**

   _____

3. **Who do you live with?**

   Отметьте только один овал.

   - ◯ With both parents
   - ◯ With one of the parents
   - ◯ With grandparents
   - ◯ With guardians

4. **Do you clean teeth regularily in the morning and in the evening?**

   Отметьте только один овал.

   - ◯ Yes
   - ◯ Only once a day
   - ◯ I do not clean teeth regularily

5. **How often do you visit dentist's office?**

Отметьте только один овал.

- ◯ Every six months
- ◯ Once a year
- ◯ Haven't visited in a long time
- ◯ Have never visited
- ◯ Difficult to answer

6. **Have you ever received dental treatment?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

7. **Have you ever visited orthodontist's office?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

8. **Did you ever use orthodontic appliances (braces, mouth kappas, trainers)? If yes, please specify the duration in the 'Other' field**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer
- ◯ Другое: _____

9. **Do you like your bite / Do you like how your teeth look?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

10. **Have you ever encountered problems interacting with your peers due to your bite?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

11. **Have you ever experienced trouble breathing via nose? Did you ever have to breath via mouth for an extended period of time?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

12. **How often are you afflicted by catarral diseases?**

Отметьте только один овал.

- ◯ Often, more than thrice a year
- ◯ Not often, once or twice a year
- ◯ Difficult to answer

13. **Have you ever received comments on your posture from teachers (caregiver)?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

14. **How would you describe your posture?**

Отметьте только один овал.

- ◯ Good posture, I do not experience any problems with it
- ◯ Adequate posture, I hunch rarely
- ◯ Tolerable posture, I experience some problems with it
- ◯ I am displeased with my posture
- ◯ Difficult to answer

15. **Have you understood your bite problem and the consequences of not treating it after visiting the dentist?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer

16. **Are you ready for orthodontic treatment (using the appliances recommended by the dentist or installing the braces) and taking proper care of your mouth cavity?**

Отметьте только один овал.

- ◯ Yes
- ◯ No
- ◯ Difficult to answer