

**THE ROLE OF SCREENINGS IN PEDIATRIC ORTHOPEDIC
AND DENTAL PATHOLOGY DIAGNOSTICS**¹**Poltava State Medical University (Poltava, Ukraine)**²**Poltava V.G. Korolenko National Pedagogical University (Poltava, Ukraine)**stepan.lytovchenko@outlook.com

Early diagnosis is necessary for successful conservative treatment in pediatric orthopedics and orthodontics. Comorbid conditions in orthopedics and orthodontics are still understudied, although, they can possess high clinical value for early detection.

The purpose of the study was to determine the peculiarities of conducting preventive orthopedic examinations of children and to investigate the prevalence of malocclusions in children with the pathology of the musculoskeletal system, in particular in children with scoliosis and flat feet.

In this study, 424 children aged 5 to 17 years (189 girls (44.6%) and 235 boys (55.4%)) who had a preventive orthopedic examination and preventive dental examination were examined and such conditions as scoliosis, malocclusions, flat feet were evaluated in these children.

Age groups analysis revealed a significant decrease of children aged 8-13 years, who underwent orthopedic examination, compared to the children aged 5-7 and 14-17 years. Also, the obtained data showed a correlation between the presence of scoliosis and the presence of malocclusion.

Further study of the possible comorbid relationship between scoliosis and malocclusions in children is important for better understanding of pathology development and for improving early detection and treatment outcomes.

Key words: comorbidity, screening, traumatology and orthopedics, orthodontics, musculoskeletal system, dentognathic system, malocclusion.

Connection of the publication with planned research works.

The work is a fragment of the research «Age aspects of staged care for orthopedic and traumatological patients with comorbid pathology», state registration number 0122U002528.

Introduction.

Pediatric preventive examinations, or screenings as they are provided today began to be carried out at the beginning of the 20th century, as one of the elements of developing preventive medicine, which was accompanied by the growth of hospital network. Examinations were mainly provided for organized groups of the population, in particular, to schoolchildren. The main attention was paid to the so-called «school diseases», namely vision and posture disorders, which with the development of industrialization and general school education began to attract more attention. Assessment of posture and limbs deformities on the first school screenings was mainly aimed at detecting not the deformity of the limbs or of the spine itself, but the underlying disease that could have caused them like poliomyelitis or tuberculosis. Among first countries where school screenings were actively implemented were the USA, USSR, Great Britain, France, Germany [1].

The history of modern evidence-based screening began in 1968 with an important publication prepared by Wilson and Jungner for the World Health Organization (WHO), in which the concept of screening was formulated as the identification of probable and undetected disease or defect through the use of tests or procedures, which can be applied quickly. Wilson and Jungner proposed ten principles as a guide for determining the feasibility of screening for a particular pathology in order to improve the health of the population. These principles started a discussion on determining the ben-

efits and harms of screening, as well as on the ethical aspects and costs efficiency associated with screening programs [2, 3].

In Japan, school screening programs for scoliosis are mandatory by law, and organization and control of their implementation takes place at the local authorities level. Scoliosis screenings mostly include moire topography and low-dose radiography. In Hong Kong scoliosis school screenings consists of a voluntary 3-level assessment conducted by the Department of Health since 1995. In Singapore, routine screening of school children for spinal deformity has been a part of the national health screening program since 1981. In other Southeast Asian countries, there are no national screening programs, although special screening is conducted in certain communities in Malaysia, Indonesia, and Vietnam [4].

In Europe, legislation and general policy regarding school screening for scoliosis varies between countries. In particular, scoliosis screening is not carried out on national level in the UK and Poland and it is carried out on a voluntary basis in Greece, Italy, Spain, Israel, Turkey, the Netherlands and Bulgaria [5].

In Australia school screening for scoliosis was introduced in the early 1980s, but in the early 1990s cost efficiency concerns led to the abandonment of most programs in public schools, however medical societies in Australia now support a national scoliosis self-screening program, calling for a more autonomous approach to diagnosis by involving teenagers themselves and their families, primary care physicians for a spine examination [6, 7].

In 2004, the United States preventive services taskforce (USPSTF) determined that scoliosis screening was not effective for adolescents aged 10 to 18 years, but already in 2018, the USPSTF concluded that the available data are insufficient to evaluate the ratio of benefits and

the harm of screening for adolescent idiopathic scoliosis in children and adolescents aged 10 to 18 years. Nevertheless, regional school screening programs for the diagnosis of scoliosis continue to function, in particular, according to the recommendations of the International Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) [8].

Comorbid diagnosis is one of the key factors in determining the general state of a child health. Determining the interrelationship of pathologies can improve the detection of diseases in the early stages of their development. From this point of view, in our opinion, the interrelationship between the development of deformations of the maxillofacial system, in particular, dysgnathia or malocclusions, and orthopedic pathology (idiopathic scoliosis, flat feet) is interesting and understudied yet. Conflicting data on such a relationship, which are described in the scientific literature, only confirm the need for further research [9-12].

The frequency of preventive dental and orthodontic screenings, as well as the frequency of screening orthopedic examinations, differs in different countries, but regardless, the number of recommended preventive dental examinations is greater than orthopedic ones. Monitoring the eruption and development of deciduous and permanent teeth is mandatory to ensure comprehensive care of the oral cavity.

Pediatric dentists make diagnosis and treat disorders of dentition in accordance with the complexity of the problem and the clinician's individual training, knowledge, and experience, using the help of specialty trained orthodontists in difficult cases.

Early diagnosis and successful treatment of a malocclusion in a growing child has both short-term and long-term benefits, while allowing to achieve occlusal harmony, ensure normal functioning, and improve facial aesthetics. Early treatment is helpful for many, but not for everyone. At all stages of occlusal development, the goals of diagnosis and treatment include: diagnosis and management of teeth growth, correction of tooth position and jaw disharmony, improvement of occlusion and, as a result, aesthetics of the smile and face, which has a concomitant positive effect on self-esteem and improvement of masticatory function. The American Academy of Pediatric Dentistry (AAPD) determines the need for routine dental examinations of children every 6 months from birth to adulthood, with a mandatory evaluation of the bite, paying special attention to malocclusions at the age of 2-6 years and adolescence [13].

In Ukraine, preventive orthopedic and dental examinations are regulated by the current orders of the Ministry of Health of Ukraine, in particular. Order of the Ministry of Health of Ukraine No. 682 dated August 16, 2010., which regulates the periodicity of examinations of schoolchildren. Also, a lot of preventive examinations are due to the child's complaints, or, more often, the parents' complaints about the state of the musculoskeletal or temporomandibular system. In terms of frequency, an orthopedic examination of children at 6 and 11 years of age is mandatory in Ukraine, other years – according to indications. Children aged 6, 11, 14, 15, 16, 17 and, depending on clinical indications, at other ages are subject to a dental examination [14].

A preventive examination by a pediatric orthopedist or a dentist, in its essence, is a set of screenings to de-

tect some of the most common pathologies, in particular: scoliosis, flat feet, limbs and chest deformities – by an orthopedist, or in dentistry – assessment for caries, malocclusions. Considering preventive examination as a set of screening programs, it is worth evaluating the importance and expediency of conducting such examinations in certain age groups or the possibility of conducting deeper, interdisciplinary, complex examinations, when doctors of related specialties can refer a child from a risk group for additional examination by another specialist based on the results of own examination.

The aim of the study.

To determine the peculiarities of conducting preventive orthopedic examinations of children and to investigate the prevalence of malocclusions in children with pathology of the musculoskeletal system, in particular in children with scoliosis and flat feet.

Object and research methods.

424 children aged 5 to 17 years who applied for preventive examinations to a pediatric orthopedist in the period of April-July 2022 and who had a previous dental preventive examination in the current year or who had undergone it afterwards were examined by pediatric orthopedist. During the study, the vast majority of children were referred to the orthopedic examination by pediatrician due to the presence of a pre-established orthopedic diagnosis, but there were also those who were referred upon reaching the age of 6 and 11 years, or were examined by the initiative of their parents.

The study was conducted in accordance with the principles of the Helsinki Declaration on the Protection of Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, and the provisions of the relevant laws of Ukraine. The study protocol was approved by the Local Ethics Committee for all participants. Informed consent of the children's parents was obtained for the study, as well as the collection and processing of patient data.

All children in the study had no previously diagnosed genetic, rheumatological, or neurological diseases at the time of examination.

The orthopedic examination included: assessment of the posture, general physical development of the child, motor functions, range of motion in the joints, deformities of the chest, spine, upper and lower limbs. The clinical examination was carried out in the following sequence:

1. Assessment of posture, gait
2. Assessment of motor functions (active movements of the upper and lower limbs)
3. Assessment of the feet and lower limbs deformities, determination of the length of the lower limbs.
4. Assessment of the the spine function, mobility in the thoracic, lumbar, and cervical regions
5. Adams test with scoliometry
6. Assessment of the chest deformities.

Scoliometry was performed to determine children who had to be referred for radiographic examination. The criterion for the need for radiography was a scoliometry deviation of more than 5 degrees. Radiography was performed in accordance with the recommendations of the Scoliosis Research Society (SRS) in a direct projection from the seventh cervical to the first sacral vertebra while standing with compensation for the need

for the difference in limb length, followed by measurement of the Cobb angle [1].

Clinical assessment of the condition of the feet was carried out based on the foot posture index (FPI-6). Feet were considered as flat feet with the score of 5 and above [15].

Examination using the FPI-6 included:

1. Palpation of the talus head location.
2. Determination of curvature above and below the lateral malleolus.
3. Determination of the position of the calcaneus (inversion/eversion).
4. Determination of the presence of deformity in the area of the talonavicular joint.
5. Assessment of the severity of the longitudinal arch of the foot
6. Evaluation of adduction or abduction of the fore-foot.

To assess the orthodontic status, in particular, the presence or absence of occlusal disorders in children who underwent a preventive orthopedic examination, a clinical examination of the state of the masticatory system was carried out, which included an assessment of the harmony of the facial structure, symmetry in the frontal plane, the relative position of the jaws in the sagittal plane, basic clinical occlusion examination and teeth location. All children who underwent an orthopedic examination and were suspected of having orthodontic pathology were examined by a pediatric dentist, or the medical records were reviewed for the previous dental examination.

Data processing was carried out using Microsoft Excel software. Analysis of statistical data was carried out using the Pearson correlation test.

Research results.

424 children were examined: 189 girls (44.6%) and 235 boys (55.4%). Children were divided into the following groups by age (table).

Table – The age groups of assessed children

Age group	Female	Male	In sum
5-7 years	77	81	158
8-10 years	23	36	59
11-13 years	36	42	78
14-17 years	53	76	129

According to the frequency of referrals, depending on age and gender, in the specified period, among the studied groups of patients, a decrease in the number of referrals was observed in the age groups of 8-10 and 11-13 years and, in general, a greater number of boys referrals (figure 1).

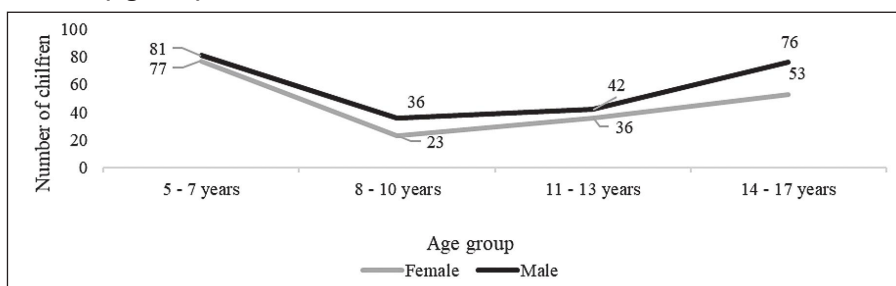


Figure 1 – Examined children age distribution.

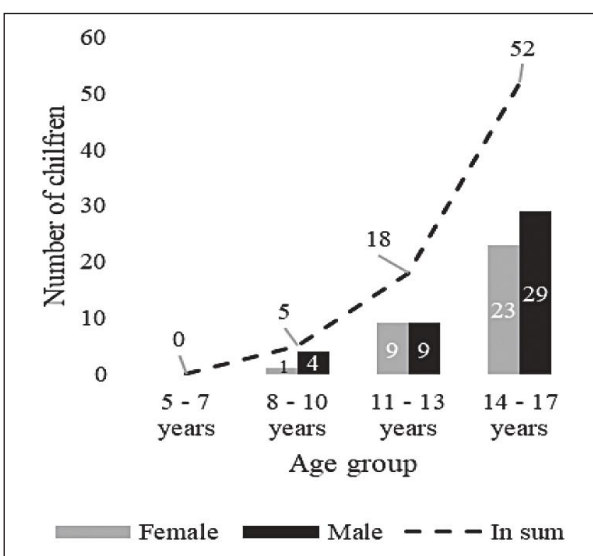


Figure 2 – First group. Children with scoliosis.

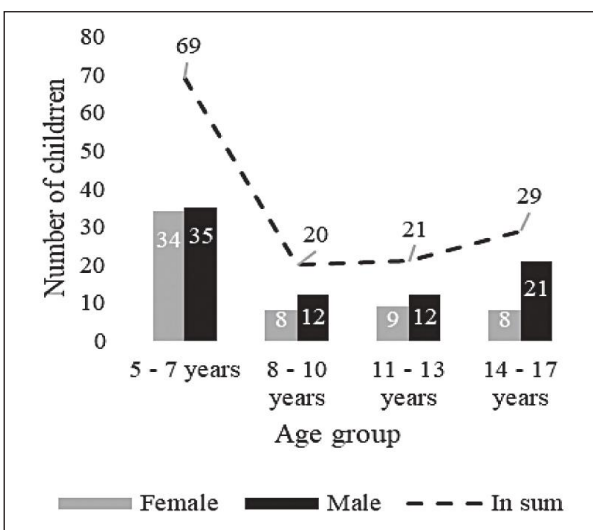


Figure 3 – Second group. Children with flat feet.

Malocclusion was diagnosed during a preventive dental examination in 252 children in total (59.4%), 114 girls (45.2%) and 138 boys (54.8%).

The four groups of examined children were formed.

The first group included those children who were diagnosed only with idiopathic scoliosis – a total of 75 children, the largest number of children with scoliosis was in the age group of 14-17 years – 52 children (40.3% of all children in this age group) and 11-13 years old – 18 children (23.1% of children of this age group) (figure 2).

The second group included those who, according to the results of an orthopedic examination, were diagnosed with only flat feet: 139 children. Among them: 59 girls and 80 boys. The largest number was in the age group of 5-7 years, 34 among girls and 35 among boys, which was 44.2% and 43.2% of all cases of flat feet respectively (figure 3).

The third group included children diagnosed with idiopathic scoliosis and flat feet.

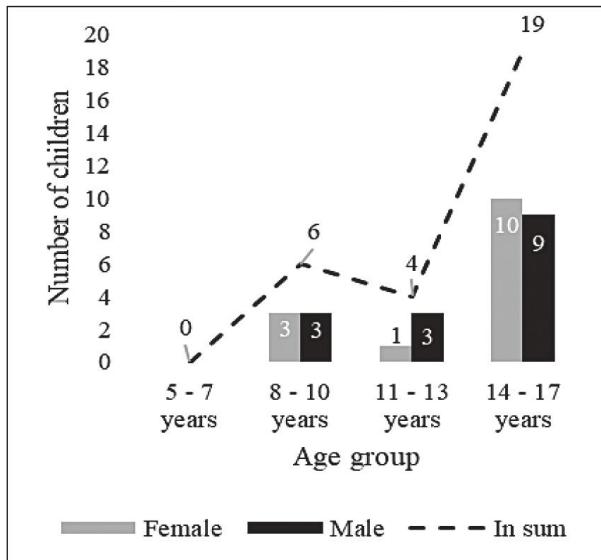


Figure 4 – Third group. Children with scoliosis and flat feet.

This group included 29 children, 14 girls and 15 boys. In general, among all examined girls, children of this group made up 7.4%, among boys – 6.4% (figure 4).

The fourth, control group consisted of children who did not have flat feet and/or scoliotic spinal deformity, the group included only those children who had either minor posture disorders or other orthopedic pathology not related to foot or spinal deformity. The group consisted of 181 children: 83 girls, 98 boys (figure 5).

In each group, an additional division was made according to the criterion of the presence or absence of occlusal disorders.

Malocclusion was diagnosed during a dental examination in 251 children in total (59.1% of all examined children), by gender – in 114 girls and 137 boys, which was 60.3% and 58.2% of the total number of examined by gender, respectively (figure 6).

In the first group, malocclusion was detected in 51 children (68%), 24 girls (72.7%) and 27 boys (64.3%) (figure 7).

In the second group, 81 children (58.3%) had malocclusion, 35 (59.3%) girls, 46 (57.5%) boys (figure 8).

In the third group, which had idiopathic scoliosis and flat feet, the presence of malocclusion was found in 20 children (69%), 10 girls (71.4%) and 10 boys (66.7%) (figure 9).

Among the children of the fourth (control) group, 99 malocclusions (54.7%) were detected. Among them: 46 girls (55.4%) and 53 boys (54.1%) (figure 10).

The analysis of the obtained data revealed a correlation between the presence of scoliosis and the presence of dysgnathia when comparing the number of children with bite disorders in the first group and the fourth, so 68% of children in the first group had dysgnathia, against 54.7% of children in the fourth group ($p=0.04$).

When analyzing the number of examined children depending on age, a significant

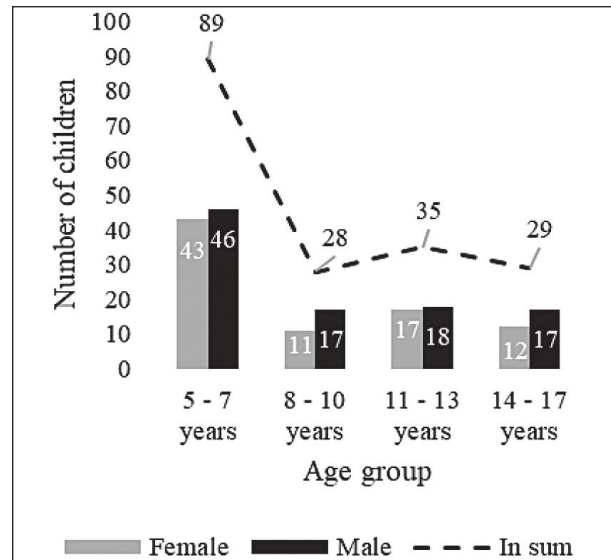


Figure 5 – Fourth group. Children without scoliosis and flat feet.

decrease in visits was found in the groups of 8-10 years and 11-13 years, compared to the groups of 5-7 years and 14-17 years (137 children, against 287 children, respectively), at the same time, the largest number of children without scoliosis and flat feet was observed precisely in the age group of 5-7 years (89 children), which may indicate excessive attention to this age group, the most cases of scoliosis were found in the age group of 14-17 years (59 of 75 cases of scoliosis (69.3%)).

The large number of children in the age group of 5-7 years and in the age group of 14-17 years can be explained by the need to obtain a health certificate for admission to primary school (ages 5-7), college and institute (ages 14-17). At the same time, the decrease in the number of applications in the age groups of 8-10 years and 11-13 years may indicate insufficient coverage of the population with preventive orthopedic examinations when they are not necessary for formal procedures, but are important in view of the probability of progression of deformities at this age.

Given the pronounced difference in the number of appeals by age, in order to exclude the possibility of a smaller number of children aged 8-13 compared to children aged 5-7 and 14-17, it was determined that according to the data of the Ukrainian state statistics service, the natural decline of the population in Ukraine in 2009-2014 (groups 8-10 years old and 11-13 years old) was lower, compared to 2005-2008 (14-17 years old) and 2015-2017 (5-7 years old). On average, the number of

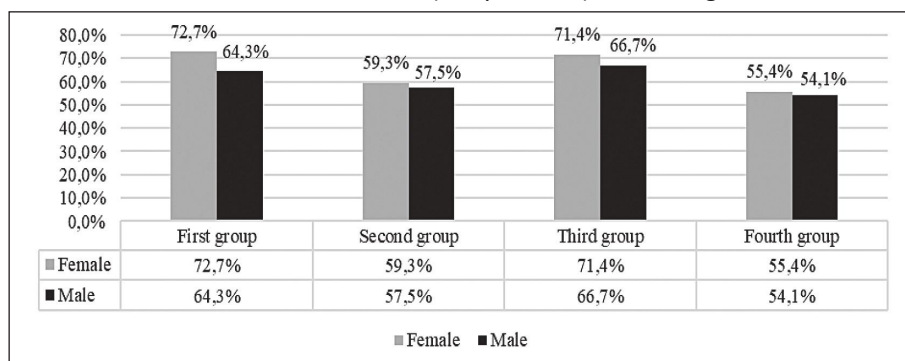


Figure 6 – Malocclusions in the examined groups.

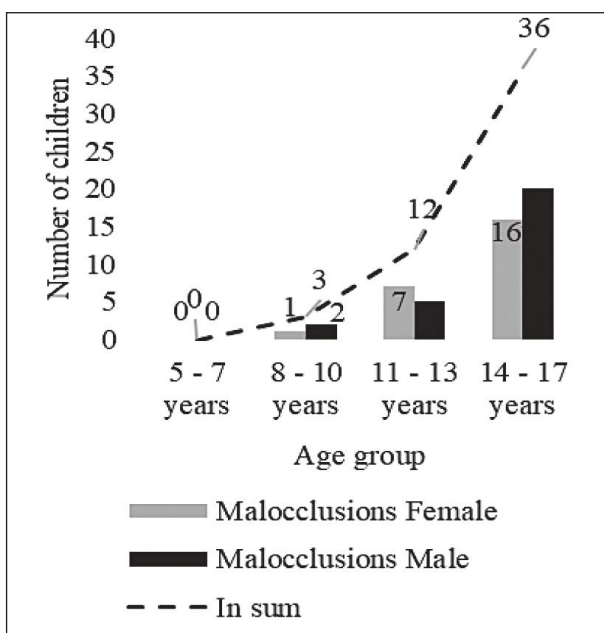


Figure 7 – Malocclusions in First group.

live births per 1,000 population was: 9.8 in 2004-2008, 11.02 in 2008-2014, and 10.1 in 2015-2017 [16].

Taking this into account, the mandatory orthopedic examinations of children at the age of 11, according to the order of the Ministry of Health, is determined by the unsatisfactorily small number of children of this age referred for orthopedic examination.

When evaluating the obtained results, attention is also drawn to the increase in the number of cases of flat feet in the 5-7 year old group (69 children (49.6% of all cases)), which can be explained by the definition of flat feet according to the FPI-6 foot posture index, feet with physiological, or flexible flat feet, which can be frequent in this age group.

Also, the largest number of children of group 4, namely, without scoliosis and flat feet, belonged to the age group of 5-7 years, with a decrease in the number of children with increasing age.

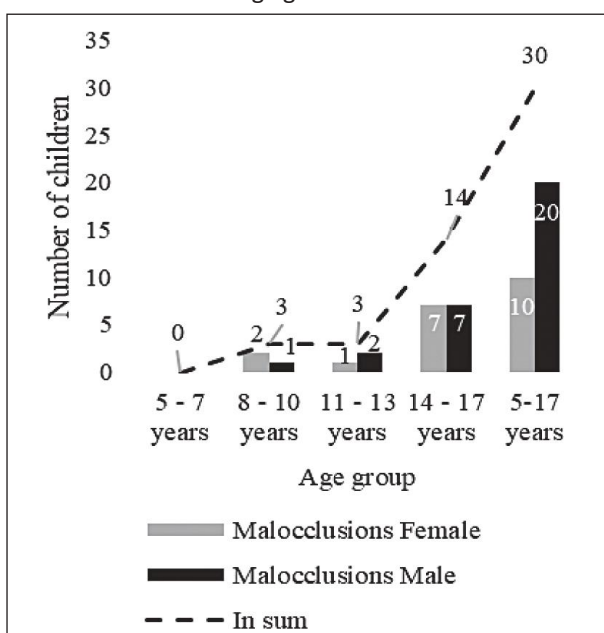


Figure 9 – Malocclusions in Third group.

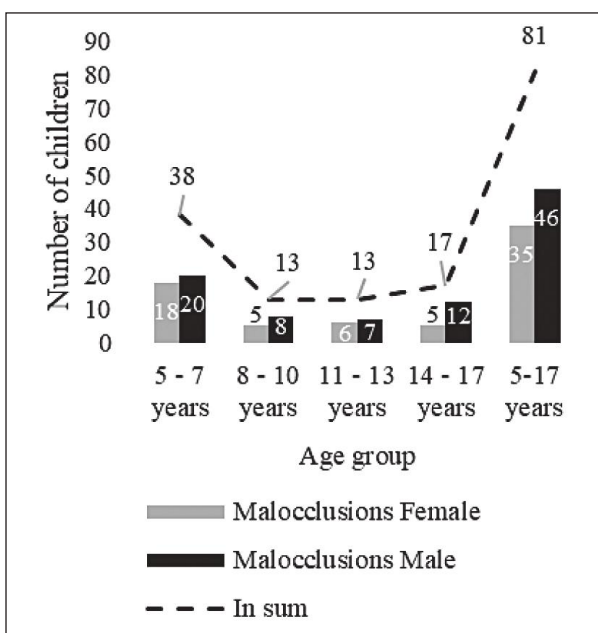


Figure 8 – Malocclusions in Second group.

Discussion of the research results.

The issue of conducting preventive examinations of children in orthopedics and orthodontics is important for early diagnosis and detection of pathology at the stages when conservative treatment is most appropriate and effective. At the same time, the need for observation and further examination of children in whom pathology of the musculoskeletal system has already been detected previously creates a significant burden on outpatient departments and may limit access for preventive examination of children by age. The use of self-diagnosis of scoliosis by parents, or the referral of children from the comorbidity risk group by doctors of related specialties, dentists, pediatricians, for consultation by an orthopedist can improve the early detection of pathology and provide the opportunity for a full examination of children at the age of 6 and 11 years.

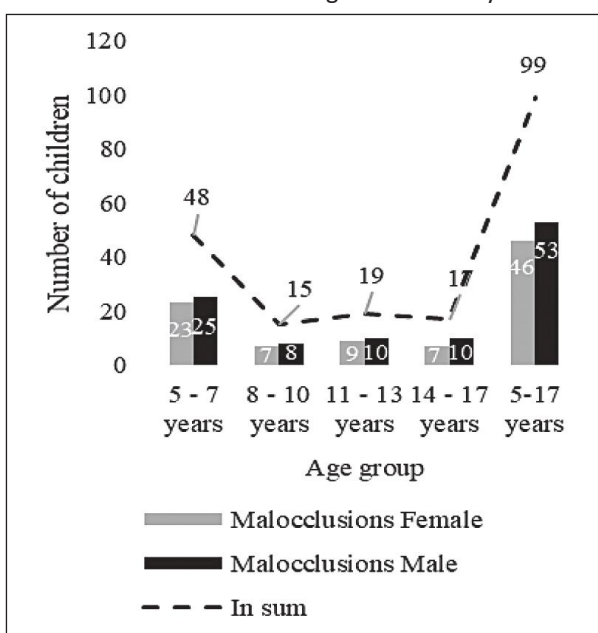


Figure 10 – Malocclusions in Fourth group.

Especially important, given the recommendations of SRS and SOSORT, is the mass examination of girls aged 11-12 years, which, together with the decrease in the number of applications of children aged 8-13 years old revealed in this study, may be one of the reasons for the increase in the number of children 14-17 years old with scoliosis or combined pathology .

Limitations of the study were the lack of assessment of quality indicators, differentiation of scoliotic deformity, flat feet by degrees and lack of determination of the type of Malocclusion, lack of a relatively large group of healthy children without orthopedic pathology to compare the prevalence of bite disorders among orthopedically healthy children.

Conclusions.

In view of the obtained results, namely the presence of a correlation between the presence of scoliosis and the presence of malocclusion, the issue of orthodontic

and orthopedic comorbidity in children requires further research. The use of a complete assessment of the state of the locomotor system in a complex with the masticatory component can have diagnostic value in determining the general state of the locomotor system in children, as well as clinical or anamnestic assessment of the locomotion system can improve the diagnosis of bite pathology, which in general, can contribute to early detection of deformities, improvement of diagnosis and treatment.

Prospects for further research.

In our opinion, it is promising to identify and clarify relationship between malocclusions and spine deformity, especially in children. Evaluating qualitative characteristics of the malocclusions and spine conditions in children with bite or spine deformities and comparing them with the ones who are healthy is in the scope of our further research.

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РОЛЬ СКРИНІНГІВ У ДІАГНОСТИЦІ ДИТЯЧОЇ ОРТОПЕДИЧНОЇ ТА СТОМАТОЛОГІЧНОЇ ПАТОЛОГІЇ

Литовченко С. О., Пелипенко О. В., Малик С. В., Березан О. І., Люблінська І. О.

Резюме. Вступ. Рання діагностика є надзвичайно важливою для забезпечення можливості консервативного лікування як ортопедичної так і ортодонтичної патології у дітей. Організація профілактичних оглядів є одним з інструментів, що дозволяє досягти раннього виявлення патології.

Мета. Визначити особливості проведення профілактичних ортопедичних оглядів дітей та дослідити розповсюдженість дисгнатій у дітей з патологією опорно-рухової системи, зокрема у дітей зі сколіозами та плоскостопією.

Об'єкт і методи дослідження. Під час дослідження 424 дітям віком від 5 до 17 років (189 дівчат (44,6%) та 235 хлопців (55,4%)) було проведено клінічне ортопедичне обстеження та стоматологічний огляд, аналіз медичних карт для визначення факторів ризику дисгнатій та наявності порушення прикусу у дитини. Для діагностики, крім загальних методів обстеження, використовувалась сколіометрія, визначення стану постави стоп за Індексом постави стоп (Foot posture index-6 (FPI-6)). Обробка даних проводилась з використанням програмного забезпечення Microsoft Excel, для аналізу даних використовувався кореляційний критерій Пірсона.

Результати. Аналіз кількості звернень залежно від віку виявив значне зменшення в групах 8-10 років та 11-13 років, порівняно з групою 5-7 років та 14-17 років (137 та 287 дітей відповідно). Також, отримані дані по-

казали кореляцію між наявністю сколіозу та наявністю дисгнатії. Кількість дітей з порушеннями прикусу серед дітей зі сколіозом була більшою, ніж серед дітей без нього (68% проти 54,7% ($p=0,04$), відповідно).

Висновки. Незважаючи на важливість ортопедичного обстеження у віці 8-13 років, кількість дітей, що пройшли ортопедичне обстеження в цьому віці була найменшою. З огляду на виявлений кореляційний зв'язок патології прикусу та сколіотичної деформації хребта, можна припустити, що діагностика одного стану може збільшити частоту раннього виявлення іншого, проте, питання коморбідності дисгнатій та патології опорно-рухової системи потребує подальшого дослідження з врахуванням якісних показників деформацій.

Ключові слова: коморбідність, профілактичний огляд, травматологія та ортопедія, ортодонція, опорно-рухова система, зубощелепна система, дисгнатії.

THE ROLE OF SCREENINGS IN PEDIATRIC ORTHOPEDIC AND DENTAL PATHOLOGY DIAGNOSTICS

Lytovchenko S. O., Pelypenko O. V., Malyk S. V., Berezan O. I., Liublinska I. O.

Abstract. *Introduction.* Early diagnosis is extremely important for conservative treatment of both orthopedic and orthodontic pathology in children. Organization of preventive examinations or screenings is one of the tools that allows to achieve early detection of pathology.

Purpose: to determine the peculiarities of conducting preventive orthopedic examinations of children and to investigate the prevalence of dysgnathia in children with pathology of the musculoskeletal system, in particular in children with scoliosis and flat feet.

Materials and methods. During the study, 424 children aged 5 to 17 years (189 girls (44.6%) and 235 boys (55.4%)) underwent clinical orthopedic examination and dental examination and analysis of medical records to determine risk factors for dysgnathia and the presence of malocclusions in a child. For diagnosis, in addition to general examination methods, scoliometry and Foot posture index-6 (FPI-6) were used. Data processing was carried out using Microsoft Excel software, for analysis we used the Pearson correlation criteria.

Results. Analysis of the number of children who underwent orthopedic evaluation depending on age revealed a significant decrease in the groups of 8-10 years and 11-13 years, compared to the groups of 5-7 years and 14-17 years (137 and 287 children, respectively). Also, the obtained data showed a correlation between the presence of scoliosis and the presence of dysgnathia. The number of children with malocclusion among children with scoliosis was higher than among children without it (68% vs. 54.7% ($p=0.04$), respectively).

Conclusions. Despite the importance of orthopedic examination at the age of 8-13, the number of children who underwent orthopedic examination at this age was the smallest. Given the revealed correlation between malocclusion and scoliosis, it can be assumed that the diagnosis of one condition can increase the frequency of early detection of the other, however, the issue of comorbidity of dysgnathia and pathology of the musculoskeletal system requires further research taking into account qualitative evaluation of deformities.

Key words: comorbidity, screening, traumatology and orthopedics, orthodontics, musculoskeletal system, dentognathic system, malocclusion.

ORCID and contributionship:

Lytovchenko S. O.: [0000-0002-5839-1978](https://orcid.org/0000-0002-5839-1978)^{ABD}

Pelypenko O. V.: [0000-0002-9010-3163](https://orcid.org/0000-0002-9010-3163)^{AF}

Malyk S. V.: [0000-0002-6683-7183](https://orcid.org/0000-0002-6683-7183)^E

Berezan O. I.: [0000-0002-4959-3594](https://orcid.org/0000-0002-4959-3594)^{CE}

Liublinska I. O.: [0000-0003-2703-4545](https://orcid.org/0000-0003-2703-4545)^D

Conflict of interest:

The authors have no conflicts of interest to declare.

Corresponding author

Lytovchenko Stepan Olexandrovych

Poltava State Medical University

Ukraine, 36000, Poltava, 23 Shevchenko str.

Tel.: +380509822203

E-mail: stepan.lytovchenko@outlook.com

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article.

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