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ANALYSIS OF THE EPIDEMIOLOGY, TREATMENT METHODS AND OUTCOMES OF METATARSAL FRACTURES IN CHILDREN

Introduction. According to WHO, 75% of the world's population has some kind of problem associated with foot pathology. The arches of the foot, formed by calcaneal bone the tarsal and metatarsal bones, allow the foot to support the weight of the body. Deformity of arches of the foot called flat feet. There are many causes of flat feet: one of them is traumatic. The main cause of post-traumatic flatfoot is fractures of the metatarsal and calcaneal bone. **The aim of the study** of this review is to systematize scientific literature data on the topic of post-traumatic flatfoot. **Methods.** In the systematic literature review conducted, we applied search filters to find literature in the text summarization domain from eLibrary, pubMED, Scopus. **Results and discussion.** The arches of the foot, formed by the calcaneal bone at the back and two heads of the metatarsal bones: I and V. Post-traumatic flat feet occurs after fractures of the calcaneus or metatarsal bones. Fractures of the metatarsal bones associated with post-traumatic flatfoot in the outcome of the disease. The literature review indicates clinically significant correlations between fractures of the foot bones and occurrence of post-traumatic flatfoot. Most of the material presented on the influence of calcaneal fractures on the occurrence of post-traumatic flatfoot with a direct correlation. **Conclusions.** There are sources on the correlation between metatarsal bone fractures and post-traumatic flatfoot. In the studies, the authors link metatarsal fractures and flat feet. They also note a direct correlation between the disease and its complications. The literature review show correlations between fractures of calcaneus or metatarsal bones and occurrence of post-traumatic flatfoot. Research in the field of fractures of the bones of the foot and post-traumatic flat feet, is relevant now and requires further scientific research. There was also a small amount of material on studies of post-traumatic flatfoot in children.

Keywords: post-traumatic flatfoot, metatarsal bones, fracture, foot fracture, osteosynthesis, children

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Introduction. The human foot is a complex structure composed of 28 bones and 33 joints, ensuring transmission of axial load from the whole body. In the foot there are three parts: the posterior (talar and calcaneus), the middle (palatal, three wedge-shaped and cubic bones) and the anterior (five metatarsus and phalanges of the fingers) [30].

Walking are the main functions of the foot, which provided by complex structure of foot. In the foot, there are three support point - the calcaneal bone, I and V heads of the metatarsal bones and two arches - longitudinal and transverse [30].

According to WHO, 75% of the population of the Earth have problems related to foot pathology, disrupting a person's normal life, which allows us to consider this problem not only from the medical side but also from the social side [24]. Out of all deformations, flat foot is 61.3%. According to the etiology, congenital and acquired flat feet are distinguished. Acquired in turn is divided into traumatic, traumatic, paralytic [56].

The main cause of post-traumatic flat foot is fractures. Their frequency distributed as follows: finger phalanxes occupy the leading position (74.3%), metatarsal bones come in second place (21.5%), tarsal bones and calcaneus make up 4.2% and 1.8% respectively of the total number of foot fractures [56].

The current problem is the early diagnosis of impairment of anatomy and function of the foot after injuries, with subsequent rehabilitation measures for effective pathogenic correction of post-traumatic flat foot.

The purpose of this literature review is to analyze and systematize data from the scientific literature in the context of metatarsal fractures, and their correlation with post-traumatic flat foot.

Materials and methods. The search for literary sources was carried out on the following databases: the Russian scientific electronic library eLIBRARY.RU, the information database of the National Library of Medicine (PubMed), the SCOPUS database. The search was conducted by the following key words: post-traumatic flatfoot, metatarsal bone fractures, children. The study includes original and review articles containing information on the topic of post-traumatic flat foot, fracture of foot bones in Russian or English. Articles 5 to 10 years old have been used predominantly.

Results and discussion. The metatarsal bones are a group of five short tubular bones in the anterior section of the foot, located between the tarsal bones and the phalanges of the fingers. The peculiarity of this fractures, especially II, III, IV, is the close attachment of bones to each other, a developed common connective apparatus, which makes displacement of bone rarer in comparison with bone fractures of other localizations [53]. Despite this, displacement fracture occurs and carry the risk of complications if not treated properly. Displacement bone fracture associated with high frequency of unsatisfactory treatment results. In 21.4% of cases, there are multiple fractures of the metatarsals, often leading to impaired foot function [29,32]. There is a high percentage of

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complications associated with bad diagnosis of fractures.

The peculiarities of regional blood supply play a special role in the development of unsatisfactory treatment results, due to slow consolidation. The development of arterial ischemia can adversely affect regeneration processes [32]. It is noted that in displaced fracture there is a direct correlation between the severity of the injury and the disruption of regional blood flow. J. P. Ardashev, V. N. Drobotova with the help of duplex scanning of the foot vessels examined 15 patients with fractures of the metatarsus. The results showed a decrease in the index of peripheral resistance in the artery [32]. These data suggest the importance of local blood supply disruption due to trauma in the development of regional ischemia. Accordingly, treatment measures aimed at improving regional blood flow should be taken.

The treatment tactics depend directly on the type of fracture of the bones. In the classification by localization, fractures of the proximal section, diaphysis, neck and head of the metatarsus are distinguished. There is an international classification of the Association of Osteosynthesis, in which fractures of the proximal and distal end are distinguished: partial and complete joint: simple, complex.

Special attention to fractures of the V metatarsal bone, as it carries a supporting function and is where the ligaments of the large tibia muscles are attached. The typical fracture is a Jones fracture, it is an extrinsic localization of the fracture of the proximal end V of the metatarsus. There is a classification according to Dameron T. B., in which the fractures of proximal section V of the metatarsus are divided into 3 anatomical zones, classification according to Stewart I. M. in which 5 fracture types are distinguished, classification according to Torg J. S., based on radiological features of consolidation [32].

Early diagnosis is an important factor in the success of displaced fracture of metatarsal bone treatment. The predominant symptom of metatarsal bone fractures is impaired walking and support function [5]. In the treatment of this fractures is used both operational and conservative method. The restoration of the original geometry, the structure of the foot arch, is the main problem of fractures of the metatarsals, which can subsequently lead to post-traumatic changes.

Conservative treatment methods are no different from those for other localization fractures, but in the case of metatarsal fractures may be ineffective due to the instability of bone fragments and eventually lead to secondary displacement with the formation of a post-traumatic flat foot [26].

If the fracture is still considered stable and conservative treatment is decided, the immobilization period is normally 4 weeks, with mandatory X-rays control. Further rehabilitation consists in wearing an elastic brace with static and then axial load [15].

In the case of unsatisfactory standing bone deposits, first of all, a closed manual reduction is performed by pulling on the toes and pressing towards the opposite of curvature, also it is possible to apply skeletal traction by Clapp [35]. However, more often in these cases resorted to surgical treatment.

The spectrum of surgical treatment methods is varied. Extracellular (plates), intramedullary (Kirschner's wire) are used. In cases where open osteosynthesis is required [48,31].

Kirsanova V. A., Kovaleva V. A., Mezzinko V. V. examined a sample of 33 patients with fractures of the metatarsal bones. Researchers found the following statistical pattern in fracture distribution: I metatarsus - 4 patients (12.1%), II metatarsus - 7 patients (21.2%), III metatarsus - 6 patients (18.2%), IV metatarsus - 7 patients (21.2%), V metatarsus - 9 patients (27.3%), multiple metatarsus fractures - 2 patients (6.1%). The primary treatment is fixation by Kirschner's wire. The results were evaluated according to the «Functional Scale for the Lower Extremities» by M. Binkley, 1999. It was found that in all cases satisfactory results were achieved with minimal complications [22]. No post-traumatic deformation was detected in these groups.

Metatarsal fractures can occur not only due to a direct traumatic factor. Metabolic disturbances of the carbohydrate exchange are a serious problem, which in some cases is complicated by traumatic fractures. Researchers J. V. Girsh, V. V. Mesheryakov [13] found that adolescents with dysmetabolic carbohydrate exchange disorders had fractures, with the main location of injuries in the projection of the heads of 2-3 metatarsus (31%). Researchers associate this distribution with the fact that localization data are high load areas. In 6.8% of adolescents, a reduction of the angle of the posterior flexion of the foot less than 40° was diagnosed, which in turn leads to an increase in plantar pressure and may complicate pathological fractures with the development of post-traumatic deformation. The most frequent findings were longitudinal flatfoot, valgus deformation of the foot, which required further correction [13].

Often metatarsal fracture studies performed on a cohort of adult patients over the age of 18. Telitsiny P. N., Grodkov S. N., Shirshov S. N. were recruited 52 subjects with lesions of the bones of the anterior section of the foot. As a result, the following distribution of frequencies was obtained for localization of fractures: in the majority of cases there were isolated fractures of the metatarsals - in 18 patients (34.6%), in second place the phalanges of the toes in 11 (21.1%) patients, and finally, combined foot phalange fractures toes with metatarsal bone fractures occurred in 9 (17.3%) patients. In 14 (27%) patients, anterior dislocation of the foot was combined with fracture dislocation of the middle part of the foot, including tarsometatarsal joint in 7 cases [45].

Data on prevalent treatment tactics are consistent with the study presented above. Operative treatment tactics were applied in 43 patients (82.7%), conservative treatment was given to 9 (17.3%) of the subjects [45].

In the postoperative period, complications were observed in 9 (20.9%) cases. The standardized scoring scale was used to analyze the work performed. Predominantly (in 6 - 75% of patients) good results were obtained (84.33 points), these are patients with isolated fractures of the bones of the anterior part of the foot. Satisfactory results (66 17.97 points) were noted in 2 (25%) cases, unsatisfactory results were not observed. In terms of surgical outcomes, 24 (72.8%) had a good score (83.25 1.99) and two (6.1%) had an unsatisfactory score [45]. In patients with unsatisfactory treatment results, further development of post-traumatic deformation of the foot was noted.

Based on this, the authors concluded that the optimal treatment method in which satisfactory results were achieved was open intramedullary osteosynthesis by Kirschner's wire, which prevented rotational, angular and axial displacement, which has significantly improved the treatment results of this pathology [45].

In addition to intramedullary osteosynthesis, other surgical treatment techniques are used for the treatment of metatarsal bones. Babovnikov A. V. developed an extramedullary fixator for osteosynthesis of fractures of the metatarsal bones. It is a plate that is attached to bicortical screws and has a curvature corresponding to the curvature, which ensures stability of fixation [44].

As a result of traumatic damage to the growing area of the bone, there is post-traumatic shortening of the bones in children and adolescents. Skvortsov A.

P., investigated and conducted surgical intervention on 5 patients with shortening of IV metatarsus. The operative treatment methods chosen are an original method and a composition of the Ilizarov apparatus with a dispersion regime of 0.25 (mm) - 2 times a day. As a result, positive treatment results have been achieved in all patients [40]

A serious problem is post-traumatic overload metatarsalgia, which develops due to the damage of the stabilizing structures of the tarsometatarsal joints and overloading of the head of the metatarsal bone, resulting in further degenerative changes, with the development of posttraumatic deformations [8]. L. S. Weil proposes in this case to use osteotomy of the metatarsal bones by the original method [23].

In adolescence, especially in boys, there is a problem of fatigue fractures of the metatarsals (march foot), due to overloading of the anterior section of the foot. Eisunt O. L. reviewed new principles of treatment for fatigue fracture of the base of the metatarsus, in particular the fifth metatarsus, using 12 adolescent patients. In all cases, the treatment method was tunneling the injury zone, with further monitoring using CT scans. As a result, all children treated had satisfactory results [11].

Based on the results of a study conducted by R. M. Tikhelov, it is claimed that post-traumatic flat foot occurs in 10% of cases among all the longitudinal arch plates (48.6% among patients according to the author). The pattern of foot damage and flatness is observed at all levels, with different correlations depending on the section of the foot [40].

Ayoglu, N., Afacan, M. Y., describe the case of multiple metatarsal bone fracture with dislocation in a teenager after a road accident. The authors describe the failure of the closed reposition and the success of the open reposition with highly dislocated fractures of all metatarsal bones in children. After eight weeks, the correct axis of all the metatarsals was marked on the X-ray. This case shows the forced need for open reposition in cases of multiple fractures with significant deformations, despite the fact that in routine practice closed low-invasive osteosynthesis is preferred [3].

When talking about flat foot in general, this term refers to the group of orthopedic disease, which is characterized by a change in the shape of the arches of the foot. They distinguish mobile and rigid flat foot, and on the presence of complaints symptomatic and asymptomatic [2].

Mobile asymptomatic (physiological) flat foot is a reflection of the stages of development of the child's foot. The formation of the arch ends at 7 years, in children's physiological flat feet can be maintained, but by 9 years in normal disappears with the possibility of its complete self-correction. The term "mobile" means that the arch of the foot returns to its normal position when the load is removed [49].

The frequency of detection of flat foot in children and adolescents in different age groups was different. The frequency of detection of flat foot has a tendency to decrease with age. Martin Pfeiffer found that flat foot were detected in 54% of children in the 3-year-old group, while flat foot were detected in only 24% of children in the 6-year-old group. In a cross-sectional study conducted in 2020, Yohannes also found that the younger one is, the more likely it is to detect flat foot. Some studies have also shown that the incidence of flat foot in children and adolescents has a tendency to decrease from 72.6% to 37.9% at age 7-12 [18].

A large-scale study on 882 asymptomatic legs of healthy children shows that mobile flatfoot is common. In most children, flatfoot develops spontaneously during the first decade of life and is within the norm observed in adults. Vanderwilde examined X-rays of the feet of seventy-four normal children aged six months to 10 years and showed a spontaneous improvement of the foot [18,20].

Etiology distinguishes between congenital and acquired forms. Panyyotis showed that the frequency of detection of flat foot was 5.0% in boys and 3.4% in girls; Martin's result showed that the frequency of detection of flat foot was 52% in boys and 36% in girls. [18,20].

The risk of flat foot in men is always higher than in women, and this risk is not significantly related to age. This difference may be due to the fact that girls grow and develop earlier than boys. The development of posture balance and physical development in girls also occurs earlier. The physiological development of the foot arch occurs earlier in girls, the development of the longitudinal arches in boys is slower than in girls, and the fat deposits in boys are thicker than in girls [26].

Mobile symptomatic flat foot is associated with hypermobile syndrome, which in turn is hereditary deterministic, and the analogue of this term in literature is the term «static flat foot» [18,20,26].

The relationship of hypermobility and deformation of the foot was investigated in the work of A. A. Kardanova, A. S. Karandina. The study cohort consisted of 138 patients with deformities at the level of the anterior part of the foot, in the process the type of elasticity of the anterior section was determined and a direct correlation between hyperelasticity and deformation of the foot was established in 11% of cases [1, 20].

The causes of a rigid symptomatic flat foot are defects in the development of the foot - rotation of the bones of the tarsus, congenital deformation of the foot with a vertically located talus bone. The causes of rigid asymptomatic flat foot are not fully understood, they may be developmental anomalies as well as neuromuscular pathology [1].

Talking about the main methods of clinical examination, the most frequently used are objective visual examination, radiography in two projections. These methods are also applicable for the diagnosis of post-traumatic flatfoot [27,28].

The diagnostic value of visual examination is small, it is considered that 30-40% of foot deformities are not diagnosed. Therefore, further diagnostic search of the doctor may be prompted by symptoms such as: deformation of the fingers with growth of the heads I and V of the metatarsals, change in the height of the arches, presence of fractures of metatarsals in the anamnesis [29].

The accurate and available method is the plantography - examination of the arch by the imprint of the floor surface. The essence of the method is to determine the degree of flatfoot in relation to the width of the loaded and unloaded parts [30]. Digital (computer) plantography, with evaluation of dynamic and static load [4], is now firmly established.

R. Z. Salykhov, Y. A. Plakseichuk conducted a of planetary changes on digital plantography in patients with foot injury [32]. The study involved 35 patients with post-traumatic foot changes. The researchers identified the development of post-traumatic flatfoot, which is characterized by an increase in the melting factor, the longitudinal flattening factor, and an increase in the area of contact between the foot and the plane in 23 (65.7%) patients. In 3 patients (8.6%), post-traumatic changes of the bony bone were observed, with a clear trend towards vasodilation of the foot and overload of the external section [38].

Another informative, available method of diagnosis of foot pathology is X-ray, which allows to examine the bone component of the foot. An important indicator is the angle of the arch of the foot, measured in a lateral projection, in norm it is equal to 125-130. When the angle is increased to 140, it is said to be flat foot

I degree, when the angle is increased to 160 II, and more than 160o in case of III degree [33].

The X-ray picture of foot deformities was studied by V. I. Shevtsov and G. V. Dyachkova using the example of 28 patients. In case of flat-foot deformity, they are determined by a change in the architectonics of the bones of the posterior and middle sections, the bases of the metatarsal bones, and there is pronounced osteoporosis with a large-looped pattern of bone trabeculae [39].

The X-ray method has become widespread in the assessment of all parts of the foot. L. N. Solomin and K. A. Ukhanov evaluated radiographs of 64 subjects in order to determine the angle between the articular line of the talus block and the axis of the I metatarsal bone, and to determine the coefficient of lengths by the head of the I metatarsal bone and the posterior edge of the talus block. As a result of this work, a method was developed for evaluating and planning corrections of traumatic deformities of the feet in the middle section. [42]

Also, at the present time, realizing all the advantages of the X-ray method, new diagnostic methods are being developed. Leonova S. N., Usoltsev I. V. developed an X-ray method on a special platform for determining the relative position of the metatarsal heads based on 48 patient studies. As a result, this method has found clinical application for determining the relative position of the heads of the 2nd, 3rd or 4th metatarsal bones, with the establishment of the boundaries pathology, which is necessary to determine treatment tactics for post-traumatic deformities [25].

However, radiography has certain features, since the obtained indicators depend on anthropometric data, individual and functional characteristics of the foot, which must be taken into account. For example, the valgus deviation of the posterior part of the foot in children aged 3 years averages 6.4°, and by the age of 6 it decreases from 4.5° to 4° on average [47].

H. B. Menz conducted research comparing the three indicators, and found a significant correlation between them. The index of the arch of the foot, the index of foot loading and the height of the arch of the foot were compared with the height of the outer edge of the navicular bone, the angle of inclination of the calcaneus (radiological indices). Using the example of data from 100 patients, Saltzman et al. There was a correlation between the height of the arch of the foot and the radiological angles of the foot [19].

There are studies by a number of authors with opposite results, which show that angular indexes are not highly specific and diagnostically reliable. For example, the angle of inclination of the talus varies in the population by 26.5 ± 5.3° and decreases with age. An important role is played by the amount of axial load on the foot during the study in patients with deformed and healthy feet [41]. K. K. Zhokha and V. L. Alexandrovich emphasized the correct technique of foot radiography, otherwise the results were considered unreliable [42]. According to the above data, it can be said that the X-ray method best manifests itself as screening for the analysis of dynamics in large groups, when comparing indicators according to standard criteria, or when clarifying the severity of deformity [41].

Computed tomography (CT) has become widespread in our time [52]. According to the results of CT, specialists have the opportunity to determine the parameters of valgus or varus deformity by constructing multiplanar reconstructions. Additional advantages of CT include the ability to measure bone density [52, 37].

Another modern method of interest is the "F-scan" device, which represents insoles with baroreceptors capable of detecting pressure changes during walking. N. N. Rukina wirh the help of this device examined 14 people with an assessment of the distribution of loads on the foot. The criteria for analysis and evaluation were data on the pressure of the feet in the projection of the II–III metatarsal bones, as a result, it was shown that when wearing "non-physiological" shoes with high heels, the pressure in these locations increases, which increases the risk of flat feet [45].

Subjective assessment of pain before and after injury and treatment in patients with foot deformity [46]. To assess these indicators, standardized questionnaires, patient-reported outcome measures scales (PROMs), are becoming more widespread [9, 17].

Several scales have been developed for the functional assessment of feet, examples are the American Orthopedic Foot and Ankle Society scale – AOFAS, or Foot and Ankle Outcome Score – FAOS [34]. The FAOS consists of 42 questions reflecting the characteristics of pain, stiffness, puffiness, daily activity, athletic activity, and quality of life [35]. This questionnaire was tested and researched by Golubev G. Sh., Khadi R. A. When questioning 68 patients with post-traumatic flat feet, the results revealed that these scales are applicable for subjective self-assessment of the results of treatment of foot pathology [51, 52].

The treatment of flat feet in children is a separate significant issue. Currently, there is no international consensus on the correct treatment of flat foot (both surgical and conservative), and opinions vary from country to country. Thus, asymptotic congenital flat feet in young children does not need treatment. This is confirmed by recent studies, which state that flat feet at an early age are the norm and disappear with the growth of the foot [53]. The influence of shoes on the formation of the arch of the foot is a debatable issue [54].

When talking about acquired symptomatic flat foot, orthopedic insoles and shoes come first in treatment. D. J. Soomekh et al. emphasize that surgery should not be rushed, since acquired symptomatic flat foot usually respond well to conservative treatment [21]. Unfortunately, there are not enough high-quality studies confirming the effectiveness of orthopedic insoles for flat feet. Pfeiffer and his colleagues have suggested that more than 90% of orthopedic treatments are unnecessary. On the other hand, surgical treatment is required in symptomatic cases that do not respond to conservative treatment, and in case of rigid forms. The presence of symptoms is an important factor when deciding on conservative or surgical treatment. Symptoms include pain and fatigue of the foot muscles [32].

The plantar fascia forms a connective tissue framework extending from the calcaneus to the phalanges, encompassing the heads of the metatarsal bone. Thus, the longitudinal arch of the foot is raised, and the toes are unbent. Some orthopedic doctors have suggested that muscle weakness contributes to the development of flat feet, and therefore recommended muscle strengthening exercises to improve the arch of the foot.

The question arises about the treatment of flat feet and prevention through wearing shoes. Rao and Joseph [54] assessed the impact of shoes on the development of the arch of the foot by analyzing the static footprints of 2,300 children aged 4 to 13 years and reported that flat feet are more common in children who wore closed-toed shoes.

Bordelon treated fifty children with custom-made inserts and reported an improvement in the transverse tarsal joint angle [56]. Gould and his colleagues suggested that arch development occurs faster during the first 2 years (up to 3 years) when using arch-supported shoes. In a Boxing study, a custom-made rigid orthosis of the foot proved effective after 24 months in the development of the

longitudinal arch of the foot in children over 6 years of age with flat feet [56]

In patients, especially the older age group, it is often necessary to resort to surgical intervention. P. P. Buravtsev and A. S. Neretin studied 6 patients with grade III transverse flatfoot complicated by a hallux valgus deviation of the first finger. These patients underwent osteotomy of the First metatarsal at the level of the distal metaphysis with simultaneous correction, and osteosynthesis using the Ilizarov apparatus, followed by osteotomy of the proximal metaphysis, and the creation of a transverse arch, with deviation of the First metatarsal bone.

Conclusions. Post-traumatic flat foot can develop with fractures of the foot bones. Fractures of the metatarsal bones associated with post-traumatic flat feet are of the greatest interest. The studied literature indicates clinical correlations between fractures of the foot bones and the development of post-traumatic flat feet. In those studies where the authors associate metatarsal fractures with flat feet, there is a correlation. The problem of tactics for treating metatarsal fractures and tactics for treating post-traumatic flat feet remains as relevant as possible. It can be said that research on the correlation of fractures of the foot bones, and in particular the metatarsal bones, with post-traumatic flat foot is relevant at the moment, and requires further scientific research. Research in the field of development and treatment of post-traumatic flat foot in children is especially important.

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POINT OF VIEW

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THE INFLUENCE OF DIET AND NUTRITIONAL STEREOTYPES ON THE BIOLOGICAL AGE OF THE INDIGENOUS POPULATION OF THE REPUBLIC OF SAKHA (YAKUTIA)

The study is devoted to assessing the impact of nutrition on accelerating or slowing down biological age in the indigenous population of Yakutia. The study involved 84 participants aged 18 to 89 years living in the central region of Yakutia. The average age of respondents was 58.0 (21.1) years. To analyze the food composition, the frequency questionnaire containing 30 questions were used. Using K-means method of the cluster analysis, two types of the nutrition were identified among the respondents. We assessed the age acceleration, calculating using three biological clock models: Horvath DNAm, Hannum DNAm, GrimAge in these groups of participants. Binary logistic regression showed that the odds of slowing biological ages increased with a moderate diet for Hannum DNAm by 6.3 times, Horvath DNAm by 21 times, and GrimAge by 15.8 times. The frequent overeating had a negative impact on the biological age of respondents. The frequency of consumption of dairy, fried, canned, salted products, and processed meat statistically significantly affected biological age. Acceleration of epigenetic age was observed in respondents with nutritional errors in the form of overeating and frequent consumption of easily digestible, high-calorie, canned foods.

Keywords: epigenetic age, Horvath DNAm, Hannum DNAm, GrimAge, age acceleration, Yakutia, indigenous population, aging, nutrition.

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Introduction. The indigenous population of the Republic of Sakha (Yakutia) is characterized by an evolutionarily developed polar (northern) type of metabolism and a protein-lipid rich diet, which is more physiological in the conditions of the sharply continental subarctic climate of the region [2, 5, 18]. The global transformation from the traditional lifestyles and nutrition, occurring in the last century, has contributed to changes in the structure of prevalent diseases and the increase of chronic non-communicable diseases among the indigenous peoples of the North [1, 3, 5, 6].

Advances in epigenetic research and bioinformatics technologies have led to the creation of "aging clocks" – digital models that allow quantitative assessment of the aging process, health level and adaptive reserve of the body [4, 11, 14]. The most well-known and studied biological clocks are Hannum DNAm [11] Horvath DNAm [12, 13], GrimAge [19], which assess biological age based on the methylation level of the genome CpG sites. Our previous study has revealed differently methylated sites in many areas of the genome when comparing the Yakut population with residents of central Russia. Representatives of the Yakut population have demonstrated a statistically significant acceleration of epigenetic age relative to central Russia for the Horvath DNAm age, Hannum DNAm age, DNAm PhenoAge, GrimAge and their improved models [15].

Studies on model organisms have shown that calorie restriction in nutrition prevents age-related changes in the methylome [8], remodels DNA profiles of genes associated with diabetes mellitus,