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# Eating disorders in preschool and primary school children with autism spectrum disorder and its clinical significance

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## ABSTRACT

Autism spectrum disorder is the fastest growing form of nervous and mental development disorder in the world. In this regard, there is a special need to resolve issues of diagnosis and correction of not only the main symptoms of this disease, but also numerous associated somatic disorders. One of the common clinical manifestations in children with autism spectrum disorder is pathological eating behavior, which includes disturbances in eating habits and preferences, frequency of meals, etc. Despite the fact that eating disorders can also occur among normotypical coevals, in children with autism spectrum disorder, these manifestations are clinically more diverse, vary in severity and often appear earlier than the main symptoms of the disease. It must be emphasized that the correction of certain nutritional disorders in this group of children is often difficult due to the characteristics of the course of the underlying disease. This may be further exacerbated by increased parental anxiety. A timely solution to the problem of eating behavior in children with autistic disorder is of great importance for strengthening their health and reducing the severity of the underlying disease, since the connection between neuropsychic and somatic health is inseparable. In the review, we tried to identify the main factors involved in the formation of eating disorders in children with autism spectrum disorder, and presented existing practical tools for analyzing this medical problem and managing their nutrition for preventive and therapeutic purposes.

**Keywords**: eating behavior; autism spectrum disorder; eating behavior questionnaires; childhood.

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# Нарушение пищевого поведения у детей дошкольного и младшего школьного возраста с расстройством аутистического спектра и его клиническое значение

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**АННОТАЦИЯ**

Расстройство аутистического спектра — самая быстрая в мире по распространению форма нарушения нервно-психического развития. В этой связи возникает особая необходимость решения вопросов диагностики и коррекции не только основных симптомов данного заболевания, но и многочисленных сопутствующих соматических нарушений. Одним из частых клинических проявлений у детей с расстройством аутистического спектра бывает патологическое пищевое поведение, которое включает нарушение пищевых привычек и предпочтений, частоты приёмов пищи и др. Несмотря на то, что нарушения пищевого поведения также могут встречаться среди нормотипичных сверстников, у детей с расстройством аутистического спектра эти проявления клинически более разнообразны, различаются по степени тяжести и зачастую проявляются раньше, чем основные симптомы заболевания. Необходимо подчеркнуть, что коррекция тех или иных нарушений питания в данной группе детей зачастую затруднительна в связи с особенностями течения основного заболевания. Это дополнительно может усугубляться повышенной обеспокоенностью родителей. Своевременное решение проблемы пищевого поведения у детей с расстройством аутистического имеет большое значение для укрепления их здоровья и снижения степени тяжести основного заболевания, поскольку связь нейропсихического и соматического здоровья неразрывна. В обзоре мы постарались обозначить основные факторы, участвующие в формировании нарушения пищевого поведения у детей с расстройством аутистического спектра, представили существующие практические инструменты для анализа указанной медицинской проблемы и управления их питанием в профилактических и терапевтических целях.

**Ключевые слова**: пищевое поведение; расстройство аутистического спектра; опросники пищевого поведения; детский возраст.

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## INTRODUCTION

Eating disorders can affect children of different ages and vary in severity. They are caused by a combination of factors [1–4], with increasing evidence indicating that environmental factors and experiences with food play a central role in their development. However, not all factors that influence eating behavior are modifiable. Eating disorders can lead to nutritional imbalances in children and negatively impact somatic and mental health, with serious lifetime consequences [5].

The prevalence of eating disorders among preschool and primary school-aged normotypic children is not well studied. According to some estimates, up to 3% of this population may experience eating disorders [6]. However, children with autism spectrum disorder (ASD), a group of clinically heterogeneous mental developmental disorders characterized by qualitative deviations in social interaction and communication methods and a limited, stereotyped, and repetitive set of interests and activities [7–9], exhibit profound and diverse eating disorders. According to research, up to 90% of individuals with ASD exhibit some form of eating disorder, which may present prior to the onset of other symptoms of the condition [10].

ASD is often accompanied by mental, neurological, and somatic health disorders, particularly gastrointestinal pathologies [11–13]. Additionally, children with ASD often show poor food interest, including frequent refusal to eat, disordered eating, food neophobia, and insistence on specific serving and presentation of food and shape and color of packaging or utensils used [8, 14–16]. This group of children are inattentive while eating and often have a gag reflex to the smell, taste, and sight of certain dishes [8, 17–21].

Understanding and addressing eating behaviors in children with ASD is crucial for promoting their health, development, and overall well-being [6].

This review aims to identify the main factors involved in the development of eating disorders in preschoolers and elementary school children with ASD and focuses on decreased or increased appetite, refusal to eat certain foods, and disordered eating, which can interfere with children's growth and development. However, severe forms of eating disorders were not considered. The review presents practical tools for analyzing the eating behavior of children with ASD and managing their nutritional intake for preventive and therapeutic purposes.

## CAUSES OF EATING DISORDERS

The causes of eating disorders remains unclear; however, research has identified several physiological factors that may contribute to their development. Understanding these physiological causes is critical for developing effective treatment and prevention strategies for these complex conditions. The causes of eating disorders can vary and may include motor awkwardness; increased sensory sensitivity to texture, taste, and smell [21–24]; and functional and organic gastrointestinal disorders. These disorders can be particularly challenging to diagnose in children with ASD [25–27].

Furthermore, eating behavior issues can be exacerbated by the quality of food choices and daily dietary habits. This can lead to further deterioration of functional and organic pathology in the digestive tract, which can negatively affect the physical development of children [26].

Eating disorders in children with ASD may be associated with a lack of the necessary motor skills to handle food. This can manifest as inappropriate behavioral responses such as fear, aggression, and motor hyperactivity [21]. Interaction disorders between the sensory and motor systems may be associated with these features, which are often ignored. It is critical to consider oral sensitivity problems and their effects on feeding when correcting eating behavior and disorders in children with ASD, as an exclusively behavioral approach may lead to underestimation of their impact [14].

### Organic lesions of the nervous system

The regulation of human eating behavior is complex and involves several brain regions, including the hypothalamus, limbic system, reticular formation, and anterior cortex of the cerebral hemispheres [28–31]. The pathogenesis of hypothalamic eating behavior disorder is multifactorial and includes morphofunctional abnormalities of the hypothalamus. Recent studies suggest that these abnormalities are associated with the pathophysiology of ASD [32, 33].

However, current studies aimed at elucidating the anatomical and functional properties of hypothalamic nuclei underlying atypical social–emotional behaviors in ASD than on eating disorders. However, research reveals that children with ASD may experience hormonal imbalances, specifically with ghrelin and leptin, which can lead to insomnia and other sleep-related issues [34, 35]. This may contribute to the common problem of excessive weight gain in children with ASD [36, 37].

The limbic system plays a role in motivating food consumption and comprises several biogenic amines (serotonin, dopamine, and noradrenaline) and neuropeptides (endorphin and enkephalin). Damage or malfunction of the gray and white matter of the brain, including the limbic system, has been associated with disorders such as anorexia and other eating disorders. Recent research indicates that the integrity of limbic-thalamo-cortical projections and reward-related circuitry plays a crucial role in regulating eating behavior and cognitive control processes [38]. Additionally, patients with ASD, including younger schoolchildren, have a persistent deficit in the volume of perikaryon neurons in the limbic system [39].

Reticular formation contributes to maintaining the overall activity of the central nervous system:

1) Providing autonomic regulatory functions (reflex acts of sucking, chewing, swallowing, coughing, sneezing, and vomiting)

2) Controlling the activity of skeletal and smooth muscles

3) Transmitting sensitive information to the limbic system, determining emotional coloration

4) Monitoring sleep and wakefulness states

Children under the age of 1 year with organic lesions of the central nervous system often experience regurgitation, vomiting, flatulence, diarrhea, and constipation. Children with ASD may exhibit neuroaxonal dystrophy, which is characterized by numerous spheroids in the brainstem reticular formation, hypothalamus, and other areas of the nervous tissue [40].

However, isolated lesions of the systems involved in regulating eating behavior are rare in both typical children and children with ASD [38]. Organic lesions of the central nervous system in children can lead to feeding or eating behavior problems at the early stages of development. Furthermore, these disorders may be detected in children with ASD even before the appearance of the main symptoms directly related to the disease [41].

Neurodevelopmental disorders, such as ASD, may increase the likelihood of developing eating problems. However, the relationship between the two is poorly understood [42]. Additionally, organic lesions of the nervous system resulting in motor awkwardness and increased sensory sensitivity to texture, taste, and smell may cause eating disorders [21–24]. Research has shown that nearly 90% of preschool and school-aged children with ASD do not process sensory information, including touch, smell, vision, and hearing, as effectively as their neurotypical peers [21].

## Organic and functional disorders of the digestive system

Digestive tract diseases in children are classified as either organic diseases or functional syndromes. Organic disorders are characterized by organ structure damage, which can range from gross developmental anomalies to enzymopathies. If organic pathology is ruled out, functional disorders may be considered. These disorders are not associated with organic pathology but may cause physical symptoms [43].

Possible risk factors for functional gastrointestinal disorders include cesarean delivery, premature delivery, antibiotic use in the neonatal period, and being underweight [44–46]. Moreover, some authors reveal that being an only child in the family, being the first-born child, having divorced or separated parents, living in an urban area, or being fed formula early may contribute to the development of these disorders [47, 48].

Children with ASD have a higher prevalence of organic and functional disorders in their digestive system compared to normotypic children [26, 49–52]. Some studies showed that constipation and selective eating are reliable indicators of such differences, which are often not primary digestive problems in children with ASD [53].

The occurrence of gastrointestinal symptoms in patients with ASD varies greatly, ranging 20%–70% [54, 55]. Khalil et al. identified a positive but insignificant correlation between gastrointestinal symptoms and ASD severity [56]. However, some researchers argue that there is no association between ASD severity and gastrointestinal symptoms [57–59]. Previous studies have demonstrated a significant correlation between atypical eating behavior and young age, increasing ASD severity, poor appetite, and constipation in children with this disease [42, 55].

Children with ASD may experience difficulties in diagnosing digestive diseases, which can result in food refusal [25–27]. Further, they may suffer from chronic constipation, diarrhea, gastroesophageal reflux, and other related problems that can lead to sleep disturbances, irritability, aggression, and indiscriminate eating [60, 61]. According to a study [62], abdominal pain and constipation may lead to defiant behavior; diarrhea may trigger hysterical behavior; and nausea may lead to anxiety, depression, and refusal to communicate. Additionally, children with ASD who experience regression of speech development are more likely to have atypical stools and a family history of celiac disease or inflammatory bowel disease [63].

In recent years, significant attention has been given to functional gastrointestinal disorders and their relationship to gut microbiota [55]. Research has shown that this is a dynamic process influenced by various factors such as the timing of childbirth, method of delivery, and nature of feeding [45, 64].

The composition of the intestinal microbiota becomes similar to that of adults only after the age of 2–3 years. The gut microbial landscape responds quickly to changes in various pathological conditions [64]. Patients with ASD who experience gastrointestinal symptoms often have microbial changes possibly related to digestive enzyme deficiencies, impaired carbohydrate absorption, selective feeding, bacterial toxins, serotonin metabolism disruption, and inflammation [65, 66].

The gut microbiome can affect brain activity through signaling molecules, immune mediators, intestinal hormones, and the vagus nerve and spinal afferent neurons [55]. Brain development and gut microbiota stabilization occur almost simultaneously around the age of 2–3 years, which is the critical age for the onset of behavioral disorders characteristic of ASD [64, 67].

Children with ASD exhibit decreased bifidobacteria levels in the intestine, which have a multifaceted impact on health. Additionally, there is a similar trend for *Prevotella* and *Veillonellaceae*, which are involved in carbohydrate hydrolysis. *Clostridia* species in the stool and the number of *Bacteroides* and *Firmicutes* are elevated in severe manifestations of ASD [68, 69].

Furthermore, chronic inflammation in the intestine can increase the permeability of its walls. Thus, food components, especially proteins, may have a toxic effect on the

central nervous system, further hindering the child's ability to socialize adequately [69].

Eating disorders may trigger or worsen secretory disorders and processes related to the hydrolysis and absorption of nutrients, leading to changes in tryptophan and serotonin metabolism. This can result in endotoxemia and inflammation in the intestine, accompanied by dysbiosis, which is characterized by a predominant increase in the number of proteolytic bacteria [70]. Such conditions may lead to gastrointestinal, metabolic, and immunologic disorders and may worsen the course of neuropsychiatric diseases, as is particularly evident in ASD [69].

Understanding the prevalence and nature of gastrointestinal disorders and their relationship with eating disorders and other associated conditions in children is beneficial for identifying ways to correct these disorders, including reducing disease severity in children with ASD, improving their communication skills and behavior, and normalizing sleep.

## PSYCHOLOGICAL CAUSES OF EATING DISORDERS

Several psychological factors, such as anxiety, stress, perfectionism, negative body image, and influences from family and peers, may contribute to the development of eating disorders in children. In normotypic children, these factors may be nonspecific and can lead to disordered eating behavior [71]. Additionally, children may develop a negative body image and a desire to conform to certain physical standards at a young age [72]. Research shows that family influences can also contribute to the development of eating disorders [73].

The psychological causes of eating disorders in children with ASD are more specific and may include sensory processing problems, difficulties with social interactions, anxiety and stress, and ritualistic and compulsive behaviors [8, 16, 74]. Children with ASD may have difficulty tolerating certain food textures, tastes, and odors owing to sensory processing problems, which can lead to dietary restrictions and limited food choices [75, 76].

Children with ASD may have difficulties with social interaction, which can affect their eating habits [77]. Moreover, they may experience high anxiety and stress levels due to communication and social interaction difficulties [78]. Additionally, some children with ASD exhibit ritualistic and compulsive eating behaviors, such as eating the same foods daily or insisting on certain brands, types, colors, or shapes of food [26, 79, 80].

## APPROACHES TO VALIDATING THE EATING BEHAVIORS OF CHILDREN WITH AUTISM SPECTRUM DISORDERS

Due to the high prevalence of eating disorders among children, researchers have noted the lack of a valid and universally accepted tool for assessing atypical eating behavior. The DSM-V provides criteria for diagnosing avoidant/restrictive food intake disorder in children [81]. However, additional tools are required to assess and clarify changes in eating behavior.

Obtaining reliable information about the nature of eating behavior in children with ASD can be challenging because of their specific behaviors and difficulties in verbal communication. To address this issue, several questionnaires have been developed for assessing eating disorders in patients with ASD, considering normal intelligence or mental retardation. Table 1 outlines the advantages and disadvantages of each questionnaire.

The CEBI questionnaire is a widely used instrument [82] that assesses eating behaviors based on observations and perceptions of adults who regularly interact with children. Parents are typically the primary respondents to CEBI because they can provide information about their child's eating habits, preferences, and behaviors.

BAMBI is a questionnaire designed for parents of children with ASD aged 3–11 years. Its advantage is the small number of questions compared to other questionnaires, which facilitates the diagnosis of eating behavior disorders among children with ASD [83].

AEQ [84] is a commonly used questionnaire for parents of children with ASD to assess behavioral changes in eating habits. However, its use is limited because of the small age range it covers. The authors aim to expand its use to include the assessment of eating behaviors in adolescents.

Although parents or caregivers are the respondents to the abovementioned questionnaires, their responses may not accurately reflect the child's eating behavior in every context or situation. Therefore, the questionnaire should be used as a tool to obtain data on a child's eating behavior. However, this information should be supplemented with other sources and observations to obtain a clearer perspective [85].

ASD-MBQ was developed by Japanese scientists for children with ASD aged 3–18 years. The questionnaire can be completed independently by children or with the assistance of their parents. However, self-reported responses from preschool and elementary school-aged children with ASD may be inadequate. ASD-MBQ assesses both symptomatic eating behavior and the social aspects of eating, such as clumsiness/manners [86, 87]. Despite the availability of the above two questionnaires, designed primarily for children to understand, individuals with ASD may generally downplay their symptoms and behaviors, creating problems in interpretation [81, 82].

Therefore, owing to the lack of dependable instruments for children, researchers still depend on clinical interviews with parents to evaluate any atypical feeding patterns linked to ASD. It is crucial to incorporate such instruments in a comprehensive assessment process, considering various sources of information and the professional opinions of experts in the field. Collaboration with health professionals

**Table 1**. Characteristics of questionnaires for the detection of eating disorders in children with autism spectrum disorder (ASD)

**Таблица 1**. Характеристика опросников для выявления нарушений пищевого поведения у детей с расстройством аутистического спектра (РАС)

| Type of questionnaire | Age, years | Analyzed aspects of eating behavior | Limitations | References |
|---|---|---|---|---|
| CEBI/*Parent Questionnaire* | 2–12 | Child's interaction with food during feeding/eating<br>Child–parent interaction during feeding<br>Refusal to eat<br>Selective eating<br>Restrictive eating<br>Overeating<br>Potential medical impact on problematic eating/eating behaviors | The tool is used clinically in children with ASD, but it was not specifically developed for this population | Archer et al., 1991 [80] |
| BAMBI/*Parent Questionnaire* | 3–11 | Selectivity toward food items<br>Disruptive behavior during food intake<br>Refusal to eat<br>Rigidity during mealtimes | Lack of a standardized scoring system<br>Dependence on cultural and contextual considerations | Lukens, Linscheid, 2008 [81] |
| AEQ/*Parent Questionnaire* | 3–4 | Demographic information<br>Development information<br>Food table that rates foods on a 5-point Likert scale | The small age range limits the use of the questionnaire among children. | Gal et al., 2012 [82] |
| ASD-MBQ/*Children's Questionnaire* | 3–18 | Selective eating<br>Clumsiness/manners<br>Interest in/concentration on food<br>Oral motor function<br>Overeating | Designed for Japanese residents in a culturally sensitive manner, which limits its use in global practice.<br>The relationship between eating disorders and possible psychiatric conditions (e.g., anxiety and depression) is not considered. | Nakaoka et al., 2019 [84, 86] |

*Note:* CEBI, Children's Eating Behavior Inventory; BAMBI, Brief Autism Mealtime Behavior Inventory; AEQ, Aut-Eat Questionnaire; ASD-MBQ, Autism Spectrum Disorder Mealtime Behavior Questionnaire.

can help overcome current limitations and improve existing approaches in assessing eating disorders and developing new coping techniques to support children with ASD [81].

However, none of the abovementioned questionnaires for identifying eating behavior in children with ASD have been validated for the Russian-speaking population. Therefore, cross-cultural adaptation and validation of the Russified version of the most effective questionnaire would provide a new tool for further research and daily practice of pediatricians.

## ORGANIZATION OF MEALS FOR CHILDREN FOR PREVENTIVE AND THERAPEUTIC PURPOSES

Food behavior patterns are established at an early age, and basic taste preferences are formed by age 4 years. Family attitudes have a significant influence on the habits that will persist into adulthood. Maladaptive food attitudes developed in infancy and early childhood can lead to eating disorders later on [88].

Research indicates that over 80% of preschool and early school-aged children with ASD exhibit food selectivity, leading to noncompliance with daily recommendations for fruit, fish, water, and vegetable consumption [14, 42, 89, 90]. Moreover, studies have shown that children with ASD do not increase their food choices (number of unique foods eaten) as they transition to adolescence [91]. In typically developing children, the percentage of this indicator ranges from 6% to 50%, depending on the method used to evaluate eating behavior [81, 92].

The quality of food chosen exacerbates the aforementioned situations. Children with ASD who have a higher susceptibility to sweet taste, including genetic susceptibility [93, 94], frequently choose gluten-containing foods and simple carbohydrate-rich foods (e.g., sugar, baked goods, etc.). Daily dietary habits in children with ASD can often lead to obesity and further deterioration of functional and organic pathology of the digestive tract [95–97].

Gluten and casein have excitatory effects on the brain owing to their opioid effects when they enter the general bloodstream through the damaged intestine [98, 99]. While there is no reliable data on the positive effects of gluten- and

casein-free diets, and they are not included in the global protocols for the management of patients with ASD, some researchers have reported positive behavioral effects with such long-term restrictions [100]. However, long-term adherence to this diet may result in body weight deficiency, anemia, and micronutrient imbalance, which can negatively impact children's health [101].

There is evidence of a positive behavioral effect of ketogenic diet in children with ASD; however, side effects, namely, risk of inflammatory reactions, constipation, and reflux, have been noted. Furthermore, the role of a specific carbohydrate diet that restricts the intake of complex carbohydrates is discussed, which reduces the symptoms of malabsorption syndrome and growth of pathogenic microflora [102].

Further research is warranted to determine the effectiveness of the Mediterranean diet, which has been shown to be effective only in treating attention-deficit/hyperactivity disorder [55, 102].

The treatment of eating disorders in children is a long-term process. Short-term goals are recommended to achieve a favorable outcome in the long term. Before proceeding with treatment, a systematic medical evaluation should be performed to rule out other potential causes of the eating disorder. Therapy for eating disorders should involve a multidisciplinary team, which may include pediatricians, psychologists, psychiatrists, nutritionists, and behavioral specialists. Eating disorder treatment studies described several interventions, including behavioral, nutritional, and oromotor interventions, and parent education [103, 104].

The pediatrician can recommend that families stick to regular meals without snacks, encourage the child to eat independently, and use behavioral approaches [104]. However, it is critical to repeatedly offer new foods. Joint management with specialists who work with the peculiarities of behavioral reactions in children with ASD is also critical. According to Reche–Olmedo et al., the implementation of sensory–behavioral approach, Applied Behavioral Analysis, and family-centered interventions are considered the most effective, which requires the involvement of allied professionals, not only pediatricians [105].

Inadequate nutrient intake due to limited nutritional interest can lead to protein–energy and macro- and micronutrient deficiencies. Whether food supplements such as vitamin complexes and microelements should be included in the daily diet remains unclear. Maternal intake of folic acid and multivitamin complexes during pregnancy has been shown to reduce the risk of ASD in children later in life. Adequate doses of micronutrients can influence the subsequent development of the child [106, 107].

Regarding the use of vitamins and micronutrients in children, supplements are typically prescribed to improve food composition, stimulate immune system function, enhance sleep quality or duration, improve cognitive abilities, and influence brain function to promote social interaction. B vitamins may be used to normalize mitochondria and enzyme system functions, particularly in cases of concomitant obesity [108]. According to research, children with low vitamin C levels may be less likely to consume fruits and vegetables, which can lead to dietary selectivity and restriction [109]. Therefore, prescribing vitamin C should be evaluated on a case-by-case basis.

Notably, vitamin D deficiency should be treated separately. Studies have shown that children with ASD have lower levels of vitamin D than neurotypical children [109]. This is due to dietary restrictions, various diets, and the use of some antiepileptic drugs [110]. ASD severity is directly proportional to the degree of 25(OH)-$D_3$ deficiency [109]. Therefore, it is crucial to include preventive or therapeutic doses of vitamin D in the daily diet to address deficiencies.

Children with eating disorders are at a high risk for deficiency for vitamins A and E and micronutrients such as Cu, Mr, Mg, Se, Mo, Zn, and others. Therefore, it is critical to individually consider these nutrients owing to their nutritional, metabolic, and drug intake patterns [108].

To correct specific metabolic disorders, such as oxidative stress, neuroinflammation, and mitochondrial dysfunction, nutritional supplements should be combined cautiously [111].

The use of probiotics to improve the composition of the gut microbiota in children and reduce inflammation of the intestinal wall has been investigated to reduce symptoms of neuroinflammation and improve digestive function in children with ASD. However, data on their effectiveness remain inconsistent [102].

The diversity of data on methods for correcting eating behavior in children with ASD, considering behavioral disorders, is an important aspect of the work of doctors in related fields. This requires the individual selection of protocols for supporting and treating patients [102]. When prescribing medication to a child, the child's medical history, clinical and laboratory parameters, and ambiguity of some scientific studies should be evaluated.

## CONCLUSIONS

Children with ASD often experience eating behavior problems. The main challenges are related to the child's inability to expand their diet adequately. This leads to a lack of necessary macro- and microelements for growth and development, both in terms of quantity and quality. This can, in turn, contribute to various pathological processes in the body, affecting the gastrointestinal, nervous, and immune systems and leading to obesity or varying degrees of protein–energy deficiency.

Owing to the poor socialization of children with ASD and frequent inability of relatives and medical personnel to adequately assess the child's condition, organ and system dysfunction may occur. This can complicate the situation in ensuring a decent quality of life for children with ASD and requires special attention from specialists working with this population group.

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## ADDITIONAL INFORMATION

**Authors' contributions**. N.A.S. — review of publications on the topic, processing of literature data, writing the text of the manuscript; R.A.F. — supervision of work, verification of critical content, approval of the manuscript text for publication; Ya.O.M. — supervision of work, verification of critical content, approval of the manuscript for publication, review of publications on the topic, writing the text of the manuscript.

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