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Effect of elimination diets on the functioning of children with autism in the opinion of parents

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Abstract:

Introduction. The autism spectrum disorder is more and more common in the world and is diagnosed in the early years of childhood. This disorder is impossible to cure, so parents are increasingly looking for the best therapies for their children. The most popular are the use of elimination diets, including gluten-free and casein-free diet. **Material and methods.** The study was conducted on a group of 95 people: 68 women and 27 men. The Cole index was used to assess the nutritional status of children with ASD. Taking into account the interpretation, it can be concluded that almost half of children with ASD have a normal nutritional status. There are 65 children with ASD who have complaints of impaired gastrointestinal function, the most common symptoms are gas, constipation, bloating and abdominal pain. **Results.** The most

common and popular of the alternative treatment support methods for a child with ASD used by parents are elimination diets. Among the most commonly used can be a diet that is either casein-free, gluten-free, sugar-free, or a diet with elimination of specific ingredients. In our study, we found that there is a significant relationship between the use of an appropriate nutritional strategy and improved digestive functioning in a child with ASD. **Conclusions.** Based on the results, it was concluded that there is a significant correlation between the use of a gluten-free diet and / or a non-dairy diet, and the improvement in the functioning of the digestive system, quality of life and behavior of children with autism. According to the subjective opinion of parents, a gluten-free and dairy-free diet improves the quality of life and behavior of a child with ASD.

Keywords: autism spectrum disorders; elimination diet; gluten-free; dairy-free

Introduction

In the European Union, people with autism spectrum disorders (ASD) account for 0.6% (about 5 million people) [1]. As a consequence of so many cases, autism has been adopted by the United Nations (UN), as one of the world's leading health problems, right next to Acquired Immunodeficiency Syndrome (AIDS), diabetes and cancer [2]. Based on the ICD-10 (International Statistical Classification of Diseases and Related Health Problems) classification, childhood autism constitutes Pervasive Developmental Disorders (PDD), which includes Asperger's syndrome [3]. The characteristics most commonly associated with this disorder are: withdrawal, aggression toward peers, repetitive behavioral patterns, interest in and play with one and the same object, speech and non-verbal communication disorders, and the occurrence of sudden crying fits. Any deviation from the daily routine can cause anxiety, fright or fear, which leads to the occurrence of uncontrollable and sudden crying or aggressive outbursts [4].

Abnormal development and multiple co-occurring disorders affect almost all children with autism [2]. Among those with autism spectrum disorders, nearly 83% have one or more neurological, psychiatric and physical comorbidities. The most common include sleep disorders, irritability, gastrointestinal dysfunction, depression, sensory disorders, anxiety, and Attention Deficit Hyperactivity Disorder (ADHD) [5,6]. Among the typical behaviors observed in children with ASD are self-aggression, sudden mood swings, anger, aggression and nervousness in situations where the level of frustration exceeds their low threshold of ability to cope with their own emotions, and altered perception to pain [7]. The most prominent negative behaviors are aggression, irritability, adaptive difficulties, hyperactivity, social withdrawal, self-injury, outbursts of sudden crying fits [8,9]. Children with autism who have symptoms resulting from gastrointestinal dysfunction show worse behavioral scores compared to children with autism without these conditions [10].

Parents of children with disabilities are looking more and more for alternative treatments in the form of nutritional therapy to reduce the symptoms present in these children [11]. Adequate care and intervention in the early years of childhood offers a chance, if possible, for proper development and a better quality of life by improving the well-being of a child with ASD [5]. The family of children with autism most often tries to use different types of diets that would have a positive effect on the gastrointestinal tract, since symptoms on its part can cause discomfort and exacerbate the negative behavior of a person with autism. In the diet of a person with ASD, products containing gluten and casein are most often excluded. Uninformed parents, as a result of a poorly chosen diet, can lead to malnutrition, obesity and overweight, as well as food intolerances in their offspring. Nutrition of a child with autism, is quite problematic, as he often has food selectivity and it is difficult to introduce new and unfamiliar foods. A common problem faced by parents of children with ASD is a disturbed, pathogenic microflora inhabiting

the intestines. All these factors have a negative impact on many aspects and deterioration of quality of life, including behavior of a child with autism. With a proper diet, negative behaviors, feelings and discomfort caused by the elimination of gastrointestinal complaints will decrease [12].

Among autistic children, the tendency for adverse reactions related to food can be detailed [13]. Allergies and intolerances to particular foods can greatly affect behavioral change [14]. It has been noted that these children are also affected by gluten sensitivity without celiac disease and inadequate immune response to gluten and casein [15]. This disorder is most often manifested by bloating, abdominal pain, passing excessive gas and lack of regular bowel movements [16]. Elimination diets are among the most common diets used by autistic children to improve their quality of life [17]. In the nutrition of people with ASD, it is very common to introduce a gluten-free diet, in which the total proportion of gluten proteins in the daily diet is abandoned, and/or a non-casein diet, which excludes the administration of dairy products and foods containing even small amounts of these products [17,18].

An inadequately balanced diet for a child with ASD contributes to mineral and vitamin deficiencies [18]. Nutrient deficiencies can be caused by abnormal digestion and absorption of nutrients in the intestines, as well as food selectivity, which is very common in individuals with autism [19]. The most commonly observed deficiencies in children with ASD are lower iron, calcium, magnesium, zinc, vitamin C, D, A, B12, B6, E, folic acid and fiber [20,21]. Absorption of food substances in children with ASD may be impaired as a result of altered intestinal microflora and gastrointestinal dysfunction. These children are characterized by hypersensitivity to touch, taste and smell which contributes to narrowed nutrition preferences [22]. Food selectivity affects the majority of children with ASD and involves food selectivity, i.e., the consumption by autistic individuals of foods with specific texture, smell, texture, temperature, color, appearance and presentation on the plate [21]. This is due to the constant need for repetition, a routine that provides a sense of security. Rejecting many foods from the diet leads to monotony, which is a consequence of many deficiencies [23]. Adequate nutrition for a child with ASD should be based primarily on anthropometric examinations, history, blood count, and awareness of the parent, as well as the help of a nutritionist [21].

The aim of this study was to evaluate the effect of nutritional therapy on improving the quality of life of autistic children in the subjective opinion of parents. It was assumed that the use of a gluten-free and dairy-free diet improves the functioning of the digestive system of a child with autism and improves the comfort of his life.

Material & methods

Participants

The study group consisted of people belonging to the Internet group of parents and legal guardians of children with ASD. The study involved 95 participants, 68 women and 27 men. The inclusion criterion for the study was consent to participate in the study and participation in all elements of the study. The survey included participation in the survey and anonymous.

Procedure/Test protocol/Skill test trial/Measure/Instruments

The survey was conducted using a proprietary questionnaire consisting of 30 questions. Dissemination of the questionnaire was carried out using the CAVI method, which allowed the survey to be completed electronically. The questionnaire was distributed to support groups of parents of children with disorders. The first part of the questionnaire included a metric for both parent and child. The parent's metric included questions regarding the demographic characteristics of the respondents (gender, age, education or place of residence) while with the child's metric parents were asked about basic information regarding their offspring with autism spectrum disorders (gender, age, height, weight). The second part of the questionnaire contained

questions related to the research problem. The questionnaire contained closed-ended type questions, and they referred the use of elimination diets in the nutrition of children with ASD and of the positive aspects of elimination diets and their impact on the child's life in parents' subjective assessment.

Nutritional status was assessed (in relation to centile grids for age and sex, respectively), using the Cole's index - CI (Cole's index) calculated according to the formula:

$$CI_{\%} = \frac{MR [kg] \times WS [m]^2}{MS [kg] \times WR [m]^2} \times 100[\%]$$

where:

MR - the actual weight of the child under study; WR - the actual height of the child under study; MS - the standard weight for the age and sex of the child under study (50th centile of weight for a child of a given age); WS - the standard height for the age and sex of the child under study (50th centile of height for a child of a given age).

Nutritional status was interpreted as follows [24]:

- >120% - obese
- 110-120% - overweight
- 90-110% - normal
- 85-90% - mild malnutrition
- 75-85% - moderate malnutrition
- < 75% - severe malnutrition

Data collection and analysis/Statistical analysis

Statistical analyses were performed using Statistica v.13.3 programs (Stat Soft Polska) and R v. 4.0.0 package (2020) under GNU GPL license (The R Foundation for Statistical Computing).

In order to present quantitative data, mean values and standard deviations - $\bar{X} \pm S$ - were calculated. For qualitative data, percentage notation was used. Compliance with normal distribution was checked using the Shapiro-Wilk test). The χ^2 test with variations depending on the sample size or U Mann-Whitney and Pearson test was used to assess correlations. A value of $p < 0.05$ was used as a criterion for statistical significance.

Results

The survey was conducted on a group of 95 people: 68 women and 27 men. The vast majority of respondents (70.53%) declared a city as their place of residence, while 29.47% of the respondents indicated a village. The age of children with ASD ranges from 2.5 to 23 years. In this case, the mean age was $M = 6.88$, and its standard deviation was $SD = 3.21$. The results are shown in Figure 1.

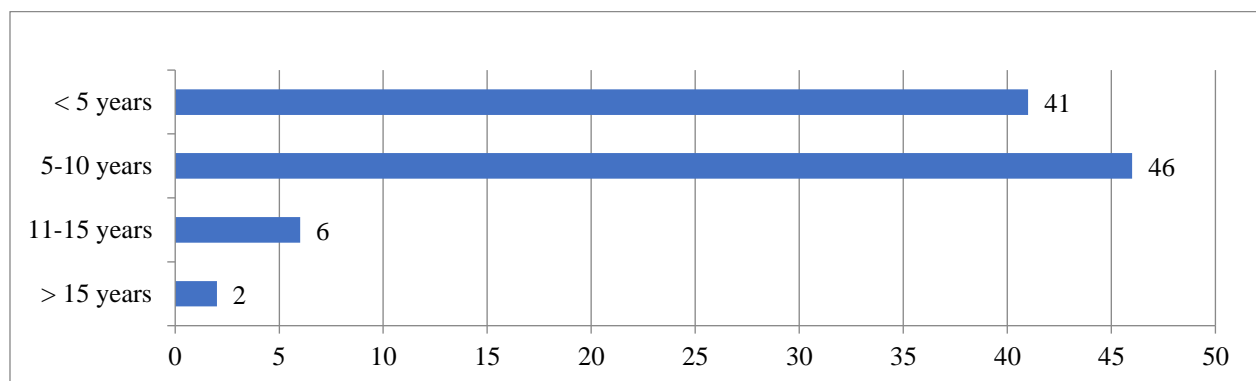


Figure 1. Age of children with ASD (N=95)

The weight range of children with autism spectrum disorder is from 15 to 68 kg (M = 26.01; SD = 11.67). In contrast, the height of children with ASD ranged from 89 to 178 cm (M = 123.07; SD = 20.08). In assessing the nutritional status of children with ASD, the Cole index was used. The analysis shows that this index ranges from 66.56% to 147.08% (M = 101.11, SD = 17.16). Considering the interpretation, it can be concluded that almost half of the children with ASD (N = 45, 47.37%) have a nutritional status in the normal range (Figure 2).

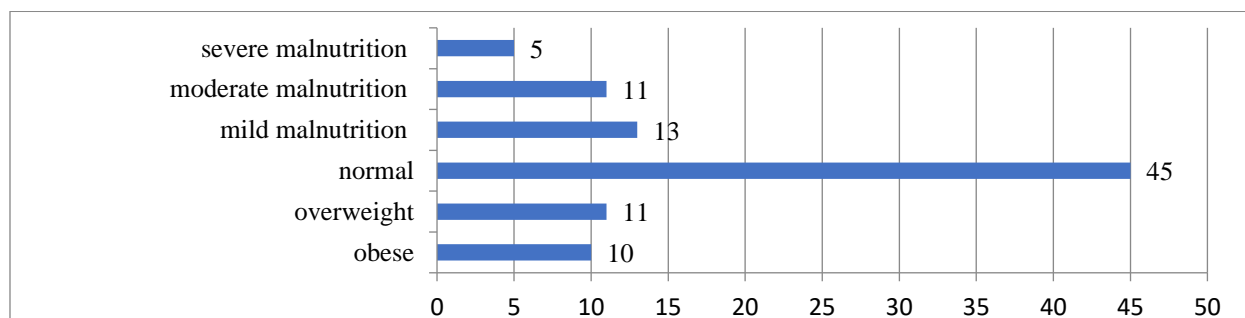


Figure 2. Nutritional status of children with autism spectrum disorder (N=95)

Almost half of the children with ASD (47.90%) do not follow any diet. About ¼ of children with autism spectrum disorders follow a dairy-free diet (24.37%), and a slightly smaller proportion have an adapted gluten-free diet (19.32%). In contrast, the smallest percentage of children with ASD follow a different diet (8.40%). Caregivers most often cited a sugar-free, preservative-free, soy-free, corn-free, yeast-free, egg-restricted diet (Table I).

Table I Dietary intake of study children with ASD (N=95)

Diet	N	(%)
Gluten-free diet	23	19,32
Dairy-free diet	29	24,37
Other elimination diet	10	8,40
Not applicable	57	47,90

There are 30 children with ASD who do not have complaints of impaired gastrointestinal function. In contrast, the most common symptoms are gas (N=26), constipation (N=25), bloating (N=22) and abdominal pain (N=20) (Figure 3).

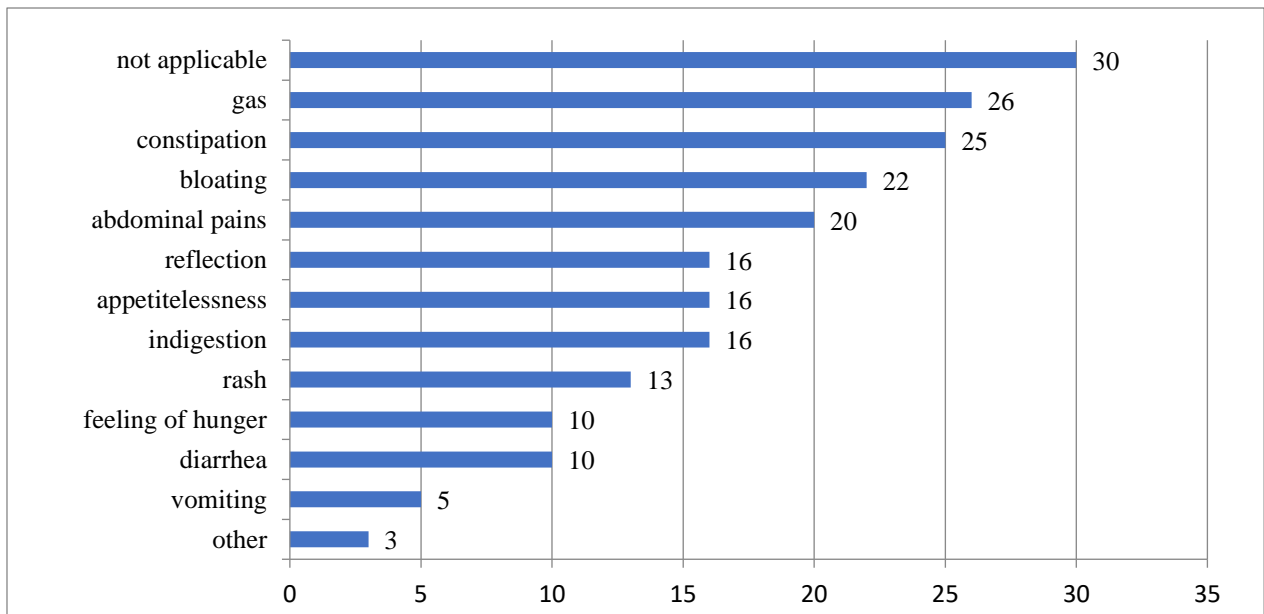


Figure 3. Ailments related to the disturbed work of the gastrointestinal tract of a child with autism (N=95)

The study determined whether there was a significant relationship between eliminating products including cow's milk protein from the diet of children with ASD, and improvement in the functionality of their digestive system, improvement in the child's behavior, and improvement in the child's well-being and behavior.

Based on the analysis, it was determined that there was a significant relationship between the use of a dairy-free diet and improved digestive functioning in a child with ASD ($p < 0,05$; $df = 2$; $Chi^2 = 29.95$). Taking into account the data obtained, it can be concluded that in children following an elimination diet, caregivers noticed an improvement in behavior after eliminating products containing cow's milk protein from the diet. Moreover, there was a significant relationship between the analyzed variables ($p < 0,05$; $df = 3$; $Chi^2 = 21.47$). In the case of children on a dairy-free diet, their caregivers believe that the nutrition of a child with ASD has a definite impact on improving the child's well-being and behavior. The analysis showed that there was a significant relationship between the variables ($p < 0,05$; $df = 3$; $Chi^2 = 32.02$). In the next step, it was determined whether there was a significant relationship between following a gluten-free diet and improving digestive function in a child with ASD. On this basis, the chi-square test was applied. The analysis showed that there was a significant relationship between following a gluten-free diet and improving digestive functioning in a child with ASD ($p < 0,05$; $df = 2$; $Chi^2 = 15.80$). Caregivers noted a significant improvement in behavior after eliminating gluten-containing products from the diet. There was a significant relationship between the variables analyzed ($p < 0,05$; $df = 3$; $Chi^2 = 13.44$). In the case of children following a gluten-free diet, their caregivers claim that feeding a child with ASD has a definite impact on improving their well-being and behavior. There was found to be a significant relationship between the variables ($p < 0,05$; $df = 3$; $Chi^2 = 21.05$).

Table I Relationship between the use of elimination diets and changes in the functioning of children with ASD

Changes	Yes	No	I don't know
Dairy-free diet (N=29)			
Improve the functioning of the digestive system	26 (89,66%)	1 (3,45%)	2 (6,90%)
Improving the behavior of a child	24 (82,76%)	2 (6,90%)	3 (10,34%)
Improving living comfort and behavior	22 (75,86%)	3 (10,34%)	4 (13,79%)
Gluten-free diet (N=23)			
Improve the functioning of the digestive system	19 (82,61%)	0 (0%)	4 (17,39%)
Improving the behavior of a child	18 (78,26%)	1 (4,35%)	4 (17,39%)
Improving living comfort and behavior	17 (73,91%)	4 (17,39%)	2 (8,70%)

The number of children with autism spectrum disorders is steadily increasing. Parents, wanting their child not to suffer the negative effects of disability, decide to look for alternative treatments to improve the child's comfort and quality of life [17]. Worldwide, as well as in Poland, more and more children and adolescents have problems with abnormal body weight. Obesity, affects many healthy children, but also those with intellectual disabilities and developmental disorders. Although more and more people are trying to lead healthy lifestyles, sweets and processed foods rich in saturated fats, dyes, preservatives and other unhealthy additives still dominate most people's diets [25]. In the own study, the weight range of children with autism spectrum disorder ranged from 15 to 68 kg, and the height ranged from 89 to 178 cm. Xiao et al. in their study noted a significantly lower height among children with ASD compared to those without autism (7.14% vs. 0%) and a lower frequency of obesity affecting children with ASD compared to those without the disorder (9.74% vs. 20.54%) [26]. Mari-Bauset et al. in their study also noted lower body weight in children with autism [27]. However, other authors describe that obesity can also affect these individuals. Dreyer Gillette proved that autistic people living in the United States between the ages of 10 and 17 were at a higher risk of obesity than those without the disability [28]. In one study, the authors observed obesity in 26% of children not following elimination diets, while children following these diets were more likely to be underweight (9%) [17]. In our own study, the Cole index was used to assess the nutrition of the respondents. It showed that almost half of the children with ASD 47.37% were characterized by a normal nutritional status. In the study group, a larger half (52.63%) were not of normal weight. The study group included children with both malnutrition and overweight and obesity.

The most common and popular of the alternative treatment support methods for a child with ASD used by parents are elimination diets. Among the most commonly used can be a diet that is either casein-free, gluten-free, sugar-free, or a diet with elimination of specific ingredients [17]. Elimination diets are used in daily life by 52.1% of respondents. The most frequently mentioned and used is a dairy-free diet (24.37%), a gluten-free diet (19.32%) and other diets (8.4%), e.g. sugar-free, soy-free, corn-free, yeast-free, egg-restricted. In Tarnowska's study, 33 parents (82.5%) eliminated gluten from their child's diet, while, as many as 22 eliminated gluten, casein and sugar from their child's diet at the same time [17]. Dittfeld et al. describe that 13% of parents report following a gluten-free and casein-free diet in a child with autism, while excluding celiac disease [18]. Other studies indicate that elimination diets have been used in 15-40% of children with autism [29,30]. According to Brondino et al, a gluten-free and non-casein diet is not effective in treating all children with ASD; it is relevant when food intolerance occurs in individuals with autism spectrum disorders [29].

According to a study done by Siudak and Cylke, 26.7% of respondents believe that the introduction of a gluten-free diet is reasonable, their opinion being that the diet is to improve

children behavior (33.3%) or digestion (30%) [31]. In our own study, caregivers of children following an elimination diet, noted a significant improvement in children's behavior after eliminating gluten-containing products and cow's milk protein from their diets. In the case of children following an elimination diet, their caregivers say that the nutrition of a child with ASD has a definite impact on improving the child's well-being and behavior. The analysis conducted showed that there is a significant relationship between the variables. In our study, we found that there is a significant relationship between the use of an appropriate nutritional strategy and improved digestive functioning in a child with ASD. It was also analyzed that there is a significant relationship between the use of an elimination diet and improvement in complaints of gastroesophageal reflux or sleep disturbance in a child with ASD.

Parents' subjective assessment of the impact of elimination diets varies. In Tarnowska's study, 72% of respondents believed that elimination diets were only for children with ASD, while 17% held the opposite view, as they believed the whole family should follow a gluten-free/casein-free diet [30].

In recent years, supplementation has become increasingly popular. When it is not possible to provide adequate amounts of vitamins and minerals with food, the use of supplementation aims to prevent deficiencies in these nutrients. Children with ASD are often characterized by deficiencies in vitamins A, D, E, K, B6, zinc, etc., among others. [20]. In a study by Trudeau et al. the most common supplementation in children with ASD was multivitamin (77.8%), vitamin D (44.9%), omega-3 fatty acids (42.5%), probiotics (36.5%) and magnesium (28.1%) [20]. Lange et al. observed that omega-3 fatty acids and probiotics were the most commonly used by parents. More than half of the children also received vitamin D, magnesium and zinc. These authors emphasize that a negative long-term deficit of omega-3 fatty acids, causes pathology in the functioning and development of the nervous system, which may have an impact on the occurrence of hyperactivity and reduced concentration among children [32]. The study by P. A. Stewart et al. involved 288 children with ASD of which 56% of children used supplementation. The most common were multivitamins, vitamin D (9%), vitamin C (4.5%) and calcium (2.4%). Children with ASD who were on gluten-free and non-casein diets were more likely to use supplementation compared to children without diets (78% vs. 53%) [33]. In our study, supplementation with vitamins and minerals was used by 62.1% dzieci, while probiotics were used in children's diets only by 22.1%.

Proper supplementation and probiotic therapy can benefit the quality of life of a child with ASD [15]. Parents of children with ASD are most likely to use additional supplements to improve their well-being or to supplement ingredients they are unable to provide with their diet or have been hindered from doing so by food selectivity. [34]. The use of supplementation should, above all, be tailored to the diet and not exceed the limits of the allowed doses. It is important to use it under the guidance of a doctor or nutritionist [32]. Shaaban et al. conducted a study in which they showed that probiotic supplementation in children with autism aged 5-9 years for a period of 3 months had a beneficial effect on weight loss, and also took into account the relationship between the use of a gluten-free diet and improved digestive function in a child with ASD. The results indicate that there is a significant relationship between following a gluten-free diet and improving the digestive functioning of a child with ASD. Parents noted a significant improvement in digestive functioning after excluding gluten, milk and dairy products from the diet [35].

People with ASD very often have to deal with complaints of gastrointestinal symptoms such as constipation, diarrhea, abdominal pain. The cause of constipation may be a diet low in dietary fiber. Dietary fiber, also protects against the development of diseases including atherosclerosis and obesity, as a low-fiber diet is associated with an increased supply of energy-dense foods [36]. These problems are strongly correlated with discomfort and increased negative behavior in a child with autism. Pathogenic microflora, digestive enzyme deficiency

or food sensitivities may be the cause [37]. In the study group, the majority of children with ASD (68.42%) have at least one trouble related to gastrointestinal dysfunction. The most common symptoms are gas, constipation, bloating and abdominal pain. Also mentioned by parents are other complaints including: vomiting, diarrhea, constant feeling of hunger, rashes, indigestion, lack of appetite, and belching. In a study by Xiao et al. the most common discomfort in children with ASD relative to children without the disorder is constipation [26]. Lange et al. also observed in 50-80% of children be on a diet without any food elimination, significantly more often gastrointestinal functioning pathologies (abdominal pain, diarrhea, bloating, constipation). According to their opinion, most complaints were associated with constipation [32]. The authors of different studies also describe that gastrointestinal complaints affect 80.2% of children with ASD, and as a consequence of their occurrence there is discomfort and increased negative behavior such as irritability, anger, aggression and sleep disturbances [8,15]. Wasilewska and Klukowski describe that symptoms occurring on the gastrointestinal side include bloating (38-60%), diarrhea (28%), belching (25%), reflux symptoms (16%) and constipation (10%) [38], while in another study, bloating affected 21% and constipation 19% of children with ASD, the cause of which were food allergies and intolerances. Eliminating gluten reduced symptoms in 57.56%, as well as negative behaviors associated with discomfort [22]. In a 2017 study, fecal microbiota transplantation was performed in 18 children with autism spectrum disorders, with an effect on improving gastrointestinal function and reducing pathological symptoms in 80% patients [35].

A very common problem affecting between 46-89% of children with autism spectrum disorders is food selectivity, which hinders proper nutrition and the introduction of new foods into the menus of people with ASD [21]. A study by Xiao et al. found that children with autism relative to those without it are distinguished by food selectivity (26% vs. 11%), very high aversion to new foods (9% vs. 1.4%), and an overall sense of serious eating problems (32.5% vs. 13.7%) [26]. In our own study, an analysis was performed, which showed that food selectivity occurs in 53.7% of children with ASD. The children studied have the biggest problem with the smell of the meal, which must not be too intense (16.2%), the meal must have a certain texture (13.2%), the taste must not be too intense (11%) and the meal must have a certain color (9.56%). In addition, in the own study, an analysis was made regarding the eating behavior of a child with ASD. Most children were withdrawn and did not try food (14.29%), reacted with crying (11.42%) and were hyperactive (5.71%).

Conclusions

Based on the results, it was concluded that there is a significant correlation between the use of a gluten-free diet and / or a non-dairy diet, and the improvement in the functioning of the digestive system, quality of life and behavior of children with autism. According to the subjective opinion of parents, a gluten-free and dairy-free diet improves the quality of life and behavior of a child with ASD. The use of elimination diets requires a lot of effort on the part of parents in preparing meals, searching for gluten-free, non-casein products and those that taste and look like their children's preferences and requirements. The positive impact and benefits in the child's functioning, improved well-being, mitigation of negative behaviors resulting from these diets is very motivating for the continued use of nutrition that excludes particular ingredients from the diet. The use of elimination diets should, first of all, be properly adapted to the individual needs of a child with an autism spectrum disorder, as well as conform to the principles of rational and proper nutrition, so that such therapy does not pose a risk to the child. The implementation of dietary modifications through the elimination of foods, can help parents with food selectivity in children and more easily accept introduced new food groups and increased nutritional value in the daily nutrition of a person with ASD. Parents need to control

the nutrition of a child with ASD, as inadequate portions, poorly balanced diets, and deficiencies in ingredients can increase negative behavior in their children.

Conflicts of interest - The authors declare no conflict of interest.

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