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ROCZNIKI PAŃSTWOWEGO ZAKŁADU HIGIENY
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OD REDAKTORA NACZELNEGO

Szanowni Państwo,

W numerze 4/2024 Roczników Państwowego Zakładu Higieny przedstawiamy Państwu siedem publikacji, związanych tematycznie z żywnością, żywieniem i zdrowiem dzieci i młodzieży. Wszystkie manuskrypty zawierają wyniki badań prezentowane w trakcie **VIII Kongresu Żywieniowego**, który odbył się w dniu 19 września 2024 r. w Warszawie. Organizatorami Kongresu, który nosił tytuł **„Partnerstwo instytucjonalne w trosce o zdrowie dzieci i młodzieży”**, byli Narodowy Instytut Zdrowia Publicznego PZH – Państwowy Instytut Badawczy i Instytut Nauk o Żywieniu Człowieka Szkoły Głównej Gospodarstwa Wiejskiego.

Ostatni numer Roczników PZH w danym roku kalendarzowym zwyczajowo zawiera również listę autorów i recenzentów. Wysoko cenimy dobrowolne przygotowywanie recenzji manuskryptów i składamy serdeczne podziękowania dla wszystkich recenzentów za wsparcie Roczników PZH.

Z poważaniem,

Prof. dr hab. Hanna Mojska
Redaktor naczelna
Roczników Państwowego Zakładu Higieny

EDITORIAL INTRODUCTION

Ladies and Gentlemen,

In No. 4/2024 of the journal Roczniki Państwowego Zakładu Higieny we present seven publications thematically related to food, nutrition, and the health of children and adolescents. All manuscripts contain the results of studies that were presented during **the 8th Nutrition Congress**, which took place on September 19, 2024, in Warsaw. The organizers of the Congress, titled **„Institutional Partnership in the Care of Children and Adolescents' Health"** were the National Institute of Public Health NIH – National Research Institute and the Institute of Human Nutrition Sciences of the Warsaw University of Life Sciences.

The last issue of the Roczniki Państwowego Zakładu Higieny in a given calendar year customarily also contains a list of authors and reviewers. We highly appreciate the voluntary preparation of manuscript reviews and would like to thank all reviewers for their support of the Roczniki Państwowego Zakładu Higieny.

Kind regards,

Prof. Hanna Mojska, PhD
Editor-in-Chief
Roczniki Państwowego Zakładu Higieny

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REVIEW ARTICLE

THE ROLE OF SENSES IN SENSORY INTEGRATION IN THE CONTEXT OF CHILD NUTRITION

Anna Piotrowska, Eliza Kostyra, Rita Karaś

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ABSTRACT

The growing problem of sensory integration disorders indicates the need to understand the role of the senses in children's food acceptance and to use this knowledge to determine actions to reduce food selectivity and neophobic attitudes. The paper analyzed the current scientific literature data concerning the impact of sensory integration disorders on children's eating behaviors. The influence of multisensory experiences and sensory education in shaping the proper eating habits of children with sensory integration disorders was also discussed. The importance of educational programs in public institutions and programs dedicated to parents' children with sensory integration disorders was emphasized. Analysis of current scientific literature data regarding the research topic (databases: Google Scholar, Web of Science, PubMed, Elsevier) was performed. Analysis of literature data indicates that sensory integration disorders affect children's eating habits and increase the risk of food selectivity and neophobic behaviors. Sensory learning-based interventions increase children's engagement and facilitate the formation of proper eating habits. Sensory education programs should be interactive and tailored to the individual needs of children with sensory integration disorders. It is extremely important to support parents in increasing their theoretical and practical knowledge.

Keywords: *sensory integration, child nutrition, senses, sensory integration disorders, sensory learning*

INTRODUCTION

The senses constitute the basis for communicating our nervous system with the outside world. We can effectively adapt to its requirements by establishing relationships with the environment. Sensory integration is the process of receiving and responding to information perceived through the senses. The ability to use the information provided is extremely important when performing various everyday activities with children. Difficulties in integrating this information trigger several processes and reactions affecting physiological, cognitive, motor and emotional functions, influencing social relationships and participation in everyday life.

Sensory integration disorders can lead to unusual eating behaviors, which are manifested by a change in the degree of liking food products, the occurrence of selective eating or neophobia. Although there are many causes of improper eating habits, it seems that too little attention is paid to the role of the senses in this regard. The increasing number of children with sensory integration disorders indicates the need for a deeper understanding of the senses' role in children's food acceptance. It will allow for better support for children affected by this problem in the context of reducing symptoms of selective eating and neophobic attitudes.

Effective forms of support should be developed for parents who are the first person to notice disturbing symptoms while observing their child's daily functioning. Theoretical and practical knowledge of sensory integration processes and disorders in this area will help them understand their child's inadequate behavior, reduce stress levels, and increase the possibilities of providing various forms of support.

THE ROLE OF SENSES IN SENSORY INTEGRATION

The senses enable us to respond to changing environmental conditions, affect our functioning in different situations and protect us. They also influence food consumption and the formation of eating habits. Seven sensory modalities work together: vision, hearing, touch (including oral touch), olfaction (smell/odor), gustation (taste), sense of balance (vestibular), and sense of proprioception (body awareness) [1].

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Sensory receptors capture external (environmental) stimuli (auditory, visual, tactile, gustatory and olfactory receptors) as well as internal stimuli originating in the body (vestibular, proprioceptive and tactile receptors). The receptors transform the captured stimulus into sensory information that is sent to the brain for processing, resulting in a specific motor and behavioral response [2]. Vestibular information is provided to many brain structures responsible for, among others, regulation of arousal, maintenance of a stable visual field, static and dynamic postural control, balance responses, bilateral coordination, and spatial perception [3]. Proprioception is the sense of body position and self-movement. Proprioceptors located within muscles, tendons, and joints transmitted signals to the brain, where they are integrated with information from other senses (vision, vestibular system) to create an overall representation of body position, movement, and acceleration [4].

Sensory Integration (SI) is a neurological process that enables the correct organizing and processing of information delivered to the brain from both the body and the environment. This process enables a person to receive sensory stimuli, interpret them, and respond appropriately to the situation. All information received by the senses must be integrated to provide a basis for the development of cognitive skills [1, 5, 6]. The sensory integration process includes four stages. In the first (registration), the brain receives sensory information from the senses. The second stage is modulation (regulating the stimulus intensity), and the third is discrimination (the stimulus is organized and interpreted to distinguish its relevance). The final stage is reaction – the brain integrates all the processed stimuli to generate an appropriate response that will lead to a specific behavior [2]. Sensory integration begins to develop in the mother's womb, through the movements of her body that stimulate the baby's brain [4].

Sensory integration ability depends on the child's age and develops in four stages. At the first stage of development, the stimuli received by the tactile system are combined, the baby can suck and may establish a bond with parents because they perceive touch as a pleasant experience. Integrating information from the proprioceptive and vestibular systems enables the child to maintain proper muscle tension and coordinate eye movements. At the second stage of sensory integration, stimuli from the proprioceptive, vestibular and tactile systems are combined, affecting body perception and length of concentration time. The child acquires the ability to coordinate both sides of the body. At the third stage of development, visual, tactile and auditory stimuli are combined, and the child begins to learn speech. Eye-hand coordination enabling the child to perform many activities including independently dressing and eating. At the last level of development, stimuli from all senses are integrated. Sensory integration allows children to respond appropriately to specific sensory stimuli coming from the environment and from the body. The ability to use information provided by various senses during everyday activities, including consumption, is very important [1].

SENSORY INTEGRATION DISORDERS

Abnormalities in the process of sensory integration are referred as sensory processing disorders (SPD) or sensory integration dysfunctions/disorders (SID). They have neurological origins and cause the brain to incorrectly process sensory inputs. Sensory processing disorders are not related to damage to the brain or senses but involve abnormalities in the processing of sensory stimuli [4]. They are defined as a condition in which one or more phases of sensory integration are altered, resulting in unadapted behavioral and/or motor responses [2]. Sensory integration disorders strongly affect children's daily functioning including eating, and may lead to stress, anxiety or even depression. Children have difficulties in performing precise activities, react inappropriately to ordinary sensory experiences, get tired more quickly, have problems communicating with parents and function worse in peer groups. Difficulties with socialization may affect the pleasure of eating in the company of others. Sensory integration disorders may impede learning by imitation, and also acceptance of varied meals that are properly balanced in terms of nutritional value which may lead to dietary inadequacies in this population [2, 7-9].

According to Miller model, sensory integration disorders have three main forms that can co-exist combined: sensory modulation disorders, sensory based motor disorders and sensory discrimination disorders. The most common is sensory modulation disorder (SMD), which involves misinterpreting the intensity of sensory information. SMD includes 3 subtypes: sensory over-responsivity (SOR), sensory under-responsivity (SUR) and sensory craving (SC) [2, 6]. The classification of sensory processing disorder and subtypes is shown in Figure 1.

Children with sensory under-responsivity may need more intense or longer-acting stimulation because they do not experience it with the same intensity as typically developing children. In turn, over-responsivity to sensory stimulation can cause an excessively strong reaction to some harmless sensations as if they were dangerous or painful. Sensory craving children needs more stimulation than others and seek it out in a disorganized way – for example, they touch everything, are hyperactive, and

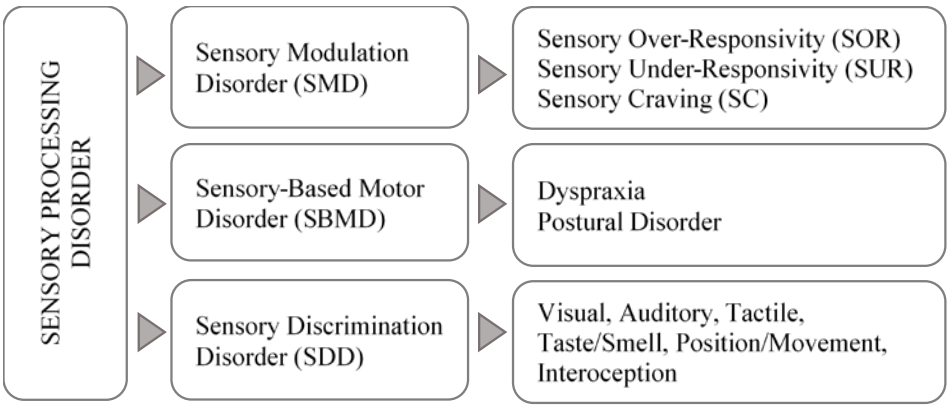

Figure 1. Type of sensory processing disorder
Source: Own elaboration based on Galiana-Simal et al., 2020 [2]

noisy [1, 3, 8, 10]. Children with sensory differentiation disorder have problems understanding the quality of sensory information. They experience difficulties identifying tastes, smells, food textures, and sounds. Sensory-based movement disorders (dyspraxia and postural disorders) mean difficulties in appropriate response to proprioceptive and vestibular stimuli. Children have problems performing coordinated movements, they seem clumsy, poorly grasp and manipulate objects [1, 4].

According to Schaaf's classification, sensory processing disorders include: poor sensory perception, sensory reactivity, somatodyspraxia (SD), vestibular and bilateral integration deficits (VBID) and visuodyspraxia (VP). Children with poor sensory perception are characterized by difficulties in identifying, differentiating, and interpreting sensory information in more than one sensory modality. Sensory reactivity, on the other hand, involves inappropriate responses to the stimulus's level, which interferes with the child's participation in daily activities. It can manifest as sensory hyper-reactivity or hypo-reactivity. In somatodyspraxia, poor sensory perception (especially tactile) is observed in combination with signs of poor motor planning. The child has problems with imitation and action planning. Vestibular and bilateral integration deficits refer to poor vestibular processing and difficulties in related motor functions, such as muscle tone, postural control, balance, visual motor skills, and bilateral coordination. Visuodyspraxia means poor visual perception with poor visual-motor skills and planning [2].

INFLUENCE OF SENSORY INTEGRATION DISORDERS ON CHILDREN NUTRITION

Sensory integration disorders strongly affect nutrition. Eating is a complex behavior which involves perceptual, cognitive, emotional and neurological processes. A meal is a complex multisensory experience requiring the combination of information from different senses, enabling the assessment of the appearance of food, its smell, texture, and taste. Usually, a meal is eaten in the presence of other people, so conversations at the table, music, or food preparation sounds engage the sense of hearing. Motor planning is also necessary to control posture and manipulation of cutlery. All these factors pose a considerable challenge for children with sensory integration disorders. For these reasons, children with sensory processing disorders would have more eating difficulties resulting from disturbances in the integration particularly tactile, olfactory, and visual/auditory information, than their typically developing peers of the same age [2, 8].

Although eating problems are not limited to children with sensory integration disorders, they are very common in this population. According to literature data, during the early years of life, approximately 25% of all children experience eating problems. This number may rise to 80% in children with developmental difficulties especially with autism spectrum disorders (ASD) [8]. A common problem is selective or picky/fussy eating, defined as eating a limited variety of food, as well as neophobia, which means rejecting unknown foods and restricting intake to known and familiar products [8, 11-14]. According to Wallace et al. (2018) children with ASD are more neophobic than children without ASD [15]. It is recognized that children with ASD demand meals to be prepared in the same way at every presentation [16]. Moreover, children consume food in the same ritualistic or obsessive way. Almeida et al. (2022) [17] point out that food neophobia (FN) is a complex problem, where a multidisciplinary-trained team should cooperate to face the situation. Researchers stressed that in the context of ASD, FN alone and in combination with other factors such as behavioral, metabolic and pharmacological affect a risk of overeating palatable

foods (e.g. high-carbohydrate, high-fat), resulting in overweight or obesity [15]. Food neophobia can cause lower BMI in children, whereas the interaction of FN and ASD traits (social, communication, and restricted/repetitive behavior) may evoke significantly higher BMI. It implies that ASD traits in combination with food neophobia have opposing influences on weight to FN alone. Further research is necessary to explain the health implications (both short-term and long-term) of FN and related food selectivity in ASD [15]. Low dietary variety in children can lead to nutritional deficiencies – among others, inadequate intake of iron and zinc (associated with low meat consumption) and dietary fiber, resulting from low consumption of fruit and vegetables, is observed [18]. Extreme food selectivity is observed in children with ASD, who may strongly prefer only one type or even one brand of food based on cues such as consistency, temperature, smell or taste [11]. Children with sensory processing disorders rarely eat the same meals as the rest of the family, have aversions to certain tastes and textures, refuse to eat certain foods because of their smell, and do not like extremes of temperature [8]. Hypersensitivity can cause the child to seek stronger stimuli, which can lead to overconsumption. Regarding taste sensitivity, overuse of salt and sugar may be observed [19]. Studies have shown that texture is the primary reason for food refusal in autistic youth. Smooth creamy textures (e.g. mashed potatoes), foods with lumps (e.g. oatmeal), and foods that require chewing are particularly problematic [12].

Research suggests that tactile hypersensitivity plays a significant role in eating problems. There is a link between tactile defensiveness and food selectivity. Exploration through touch is an essential preliminary step in introducing new foods to young children's diets. Children who demonstrate tactile defensiveness avoid exploring food with their hands. Older children have difficulties handling cutlery, other children's proximity, or routine cleaning after meals [7, 8, 20]. Children with sensory integration disorders may also have oral tactile defensiveness, which causes them to overreact to harmless tactile stimuli that come into contact with the mouth or oral cavity. They often spit out food or vomit, if they do not accept its consistency or temperature [19]. This over-reactivity, common in autism spectrum disorders, manifests as avoidance or negative behavioral responses to stimuli such as food. Compared to typically developing peers, children with ASD are much more likely to refuse food because of its texture/consistency [11]. Studies conducted among children with autism showed that those with oral sensory oversensitivity refused more foods, including whole grain products, and ate fewer vegetables compared to children with typical oral sensory sensitivity. It can impact the quality of the child's diet, leading to deficiencies in fiber and other valuable nutrients. In turn, oral under-sensitivity, in which the child does not adequately perceive stimuli, may result in consuming large amounts of food and stuffing mouth [7].

In the case of visual hypersensitivity, children often prefer products with little variety of colors, and an colorful appearance of the served meal may cause its rejection [19]. Children with hyperreactivity to sound may avoid eating meals, especially in kindergarten,

Table 1. Main characteristics of sensory modulation dysfunction for the senses

Senses	Hyposensitivity	Hypersensivity
Auditory	Children tend to be very noisy during various tasks. They listen to music at high volume and like noisy objects, often shout to stimulate themselves	Children are disturbed by loud noises such as thunderstorms, rockets and human noises. They feel uncomfortable in crowds
Visual	Children like lights, reflections and bright colors	Children are sensitive to light, they tend to look down. They have very sharp eyesight
Olfactory	Children tend to smell food before eating. They are influenced by strong smells	Children can avoid various odors
Taste	Children eat anything, they tend to put everything in their mouth	Children tend to eat very little. They reject different tastes/flavours and easily vomit
Tactile	Children seek to touch, cuddle or caress	Children have difficulties with hyperreactivity during dressing and eating. They try to avoid bodily contacts
Vestibular	Children poorly register vestibular stimuli. Difficulties are observed in attention, fine motor skills and laterality	Children avoid games and exercises that involve movement and balance, such as swings, climbing, slides
Proprioceptive	Children present poor body control. They feel that their body is heavy	Children are constantly on the move and have problems with attention

Source: Own elaboration based on Vives-Vilarroig, Ruiz-Bernardo and García-Gómez, 2022 [9]

child care or school, because the noise level is too high for them. Even sounds accompanying their own consumption (crushing the product in the mouth, chewing, crunching) may be a problem in particularly sensitive children. Excessive visual sensitivity may cause children to react more strongly to the visual stimuli of foods that may evoke unpleasant memories of their taste or texture [8]. Sensory modulation dysfunction for the senses are shown in Table 1.

Research suggests that children with autism may demonstrate atypical reactions to tastes and odors that strongly influence their eating behavior. This can manifest in both the difficulty of identification (higher sensitivity threshold) as well as very strong aversive reactions caused by hypersensitivity. Scientific studies show that children and adolescents with high-functioning autism had difficulty identifying sour and bitter taste as well as common odors compared to their typically developing peers. However, there were no differences in recognizing sweet and salty taste [7, 21].

NUTRITIONAL PROBLEMS OF CHILDREN WITH SENSORY INTEGRATION DISORDERS

Problems with sensory integration affect diet and nutritional status. Between 46% and 89% of children with ASDs exhibit nutritional challenges [22]. They often prefer junk food calorie-dense, carbohydrate-dense with high sodium, and reject fruits, vegetables as well as whole grains products [22-24]. Low intake of antioxidants, which are abundant in fruits and vegetables, can lead to the accumulation of oxidative radicals and cause a deterioration in the mental and physical condition of children with ASD [24]. Consuming foods with high-calorie density can lead to excessive weight gain. Children with ASD have higher rates of obesity than children without ASD [25]. This may also be due to a sedentary lifestyle and the side effects of medications. Children with ASD are less likely to participate in any physical activity, leading to overweight and obesity. Many medications, such as antipsychotics, stimulants, and antiepileptics, play a significant role in weight gain. Encouraging children with ASD to engage in physical activity adapted to their abilities is extremely important, not only in weight management. If it is properly organized, it helps release stress and also provides social interactions [23, 24, 26]. Apart from obesity, children with ASD are at risk for malnutrition. This may result from inadequate energy intake and the problems caused by improper absorption of nutrients from the intestines [27]. Most studies indicate that the protein intake by children with ASD is adequate. Data on fat and carbohydrates are ambiguous – both too high and correct intake in the diet are found. Children with ASD are a population group particularly vulnerable to deficiencies in fibre as well as certain vitamins and minerals. Too low intakes of vitamins A, D, and C, folic acid, as well as calcium, iron and zinc are often observed [23, 25, 27-30].

Abnormal intake of some dietary nutrients observed in children with ASD may also result from gastrointestinal disorders, intolerances and allergies. A significant percentage of children with ASD follow a gluten-free or casein-free diet, which increases the risk of calcium and fibre deficiencies [25]. Many children with ASD show abnormalities in gastrointestinal physiology, including increased intestinal permeability, overall microbiota alterations, and gut infection [25, 27, 29]. A diet high in carbohydrates and low in fibre often observed in children with ASD, may exacerbate or determine gastrointestinal symptoms (e.g. constipation) – fibre supports intestinal transit, and its low supply in the diet increases the risk of constipation. Constipation and diarrhoea are often associated with an altered gut microbiota composition. Intestinal dysbiosis is often associated, in the ASD population, with an alteration of the barrier of the intestinal mucosa with a consequent increase of the intestinal permeability to exogenous substances of alimentary or bacterial origin, in some cases even neurotoxic [25]. Gastrointestinal disorders, like diarrhoea or constipation, occur in nearly half of ASD children, and their incidence increases with age [27]. They can affect the absorption and utilization of nutrients from the diet. In addition, imbalances in different types of gut flora may result in decreased synthesis of some B vitamins, worsening nutritional deficiencies [28]. Scientific research indicates a close relationship between the functions of the intestines and the brain, the so-called "gut-brain axis", including neural, immunological, hormonal and metabolic pathways [25]. Appropriate dietary treatment of gastrointestinal symptoms can bring major relief to the symptoms of autism [27]. Scientific research indicates that the use of a diet adapted to the individual needs of a child with ASD can alleviate its symptoms and also the accompanying diseases. There is a need for supporting parents by doctors, dieticians, and specialists in the field of sensory therapy because changing the way of eating in this group of children is a special challenge.

SUPPORT AND DEVELOPMENT OF CHILDREN WITH SELECTIVE EATING HABITS

Yamane, Fujii and Hijikata (2020) [31] investigated the relationship between developmental assessment and type of support for autistic children with selective eating habits. They stated that developmental assessment is key to selecting optimal support

strategies. Four groups of children with different factors in the selection of foods such as sensory, visual, familiarity and environmental stimulation were identified (Figure 2). Special meals have been developed for three groups (without the group with environmental stimulation) based on research results. The children assigned to group one tended to select foods based on touch or a preference for crunchy products (e.g. snacks). In this case, support was related to the offering of foods that reflected the preferences for texture, smell, taste, temperature and color. The children of group two tended to prefer foods with thin shapes or meals with their favorite seasonings or sauces (e.g. mayonnaise, ketchup). In contrast, children of group three preferred to consume familiar foods. Considering this, support consisted of serving foods that imitated family recipes. Furthermore, the researchers encouraged the children to consume new foods by rewarding them with their favorite meals. A critical issue in the research was the support of the children's families. In this insight, key information on used recipes or ingredients was provided to the family. In addition, the family was supported by helping them to prepare the proposed meals. The research highlights that it is difficult to determine which type of diet would be appropriate for each child at an early stage. According to researchers, an assessment of the developmental and sensory factors of each group would be useful to determine the type of support needed for each child [31].

Yamane, Fujii and Hijikata (2020) [31] emphasized the importance of the following aspects related to the support: 1) creation of a consumption environment that provides comfort and ease of eating, preparing food the child can eat, alleviating the anxiety associated with consuming a meal, progressive inclusion of less favorite foods, 2) preparation favorite foods, developing child's interest eating, preparing products the child prefers and encouraging the child to try new foods by touching or licking them, 3) cognitive development or social interaction of children, improvement of individual level of their development, improving the food-related behavior through the consumption of unfamiliar foods in the presence of favorite persons and 4) making sure that the child's hunger is not satisfied only with favorite foods and to arouse interest in trying new meals.

The literature emphasizes that living and caring for a child with an eating sensory disorder was described as a lonely, difficult and unsupportive journey for many parents. The research found that raising awareness and improving parental support was key to understanding children's consumption problems [13]. On the other hand, parents realized that improvement would come through a long-term effort involving patience, persistence, strength and optimism. Acceptance of a child's sensory integration disorder by the parent, family and wider community can affect a positive relationship with solving various problems and coping with challenges. In the study by Cunliffe, Coulthard and Williamson (2022) [13] parents gradually adopted a positive and accepting attitude regarding their child's eating. The acceptance process determined positive food-related interactions with the child (e.g. cooking and playing with food). This indicated that experience-based interventions serve an important purpose in this population. It was stressed that further research should determine the impact of parental interventions

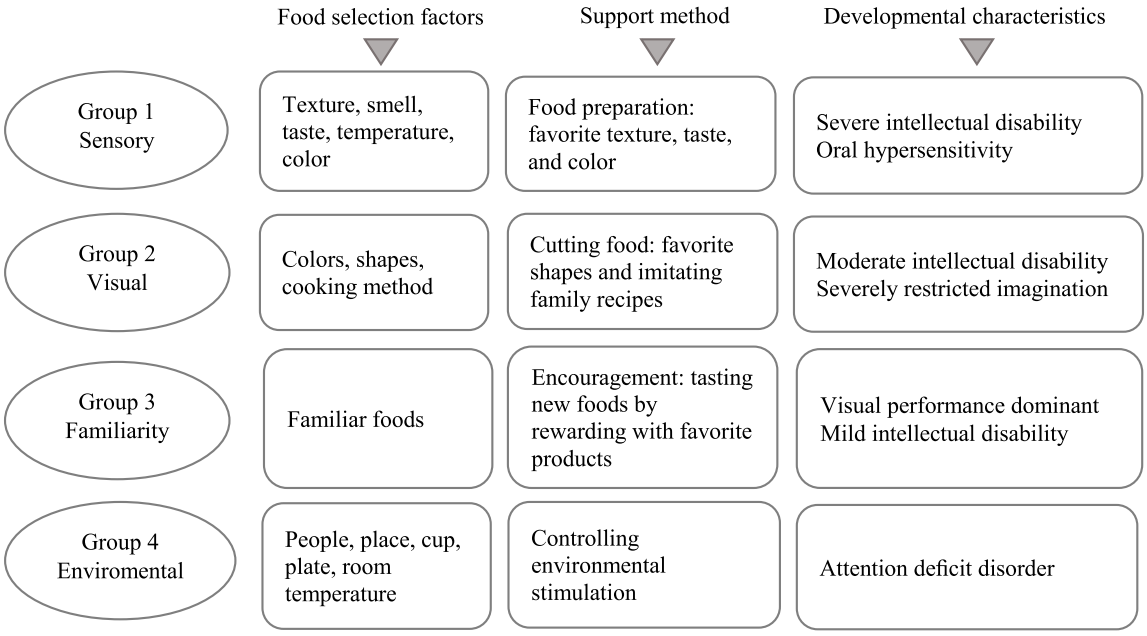

Figure 2. Support type and the developmental characteristics of children with autism
Source: Yamane, Fujii and Hijikata, 2020 [31]

based on acceptance of the child's eating behavior and engagement in gradual positive eating interactions on parent-child support strategies [13].

It was noted that a sensory diet could improve executive functions in children with ADHD [32]. According to Motahari-Muyed, Asgari and Gharebaghi (2015) [33] sensory integration therapy was effective in symptoms of ADHD: attention deficit, hyperactivity, and impulsivity. In the study of Khanahmadi at al. (2023) [34] the effect of using a sensory diet smartphone application by mothers on the main symptoms of children with ADHD (attention deficit, impulsivity, hyperactivity) was examined. It was stressed sensory diet smartphone applications may be an effective approach for reducing attention deficit experienced by children with ADHD.

THE ROLE OF INTERVENTIONS IN SENSORY INTEGRATION DISORDERS

The intervention protocols have been proposed by scientists from different fields to determine the effect of sensory exposure such as unisensory and multisensory familiarization (with or without context) on the selectivity of food and/or their acceptability by children with sensory integration disorders [11]. For example, the researchers measured the impact of different unisensory and multisensory exposures (visual and/or tactile) on vegetable consumption among preschool children with ASD having a moderate level of food selectivity [35]. The program was carried out for six months (with a 5–10 min daily vegetable exposure, four days a week). There was a significant increase in vegetable consumption in the exposed group to the control group after six months of intervention. There were no differences between the examined groups in terms of tasting and touching vegetables.

Luisier et al. (2019) [36] stated that olfactory familiarization could positively influence the perception of food attractiveness in children with ASD. In the study, the stimulus was unimodal (odor) and presented in the context of real life and relational context. Twenty-five children (aged 5–13 years) were exposed to one olfactory food stimulus four times by five weeks. The results revealed an effect of familiarization on emotional reaction to odors in ASD children. It was found that children reacted facially more positively to the odor after familiarization with it. Furthermore, more than two-thirds of children with ASD chose foods with a familiar odor.

In another study, a 12-week sensory-based consumption intervention was conducted with 19 children with ASD [37]. All the children showed communication problems and most of them had challenging behavior. The regular school personnel following training and supervision performed a targeted food selectivity intervention in school. The interventions followed the developed procedure according to the Sequential Oral Sensory (SOS) approach with sensory texture desensitization in an emotionally positive context. The study results found that after the intervention, the children tried and ate a greater variety of foods during snacks within the examined food categories (e.g. fruit and vegetables and sauces). Furthermore, the researchers observed improvements in some mealtime behaviors, including no refusal to eat, less selective eating, and a reduction of disruptive consumption behavior.

The researchers highlighted that unisensory and multisensory interventions may be useful in improving food selectivity in children with ASD [8]. It was suggested that progressively working on the hedonic properties of sensory stimuli could influence openness to the consumption of new products and meals in children with ASD through sensory familiarization. However, it is important to note that children reacted differently to the intervention. Therefore, it becomes necessary to analyze each situation individually to meet the child's needs. It was noted that tolerance to food stimuli could be mediated and corrected by support and sensory interventions. Graduated exposure therapy is one of the key elements to achieving positive consumption outcomes in children with various disorders and problems.

According to Nadon et al. (2011) [8], the caregiver should "assess the child's overall level of arousal before mealtime and may intervene to ensure an optimal state for eating". The child must have the opportunity to explore new foods through the sense of smell, taste and touch, starting by exploring familiar foods or objects outside of the mealtime context if the anxiety levels are too high.

CONCLUSIONS

With the growing problem of sensory integration disorders, it is becoming important to understand the role of the senses in children's recognition of the sensory characteristics of different foods, their acceptance and, consequently, the reduction of neophobic attitudes.

Sensory learning-based interventions support children's engagement and facilitate the formation of appropriate eating habits. Sensory education programs should be interactive and involve children in a variety of practical tasks (e.g. educational stories, drawing, games, cooking and food consumption). These approaches give children an incentive to try unfamiliar foods through increased awareness, curiosity and interaction with their peers.

It is pointed out that repeated exposure of new products to children is not a technique widely used

by parents at home despite the proven positive effects in this respect. There is potential for unisensory and multisensory intervention to influence children's willingness to eat new foods. Researchers emphasize that hands-on activities with unfamiliar products (fruit and vegetables) can increase children's willingness to try them especially those with sensory integration disorders. It is crucial to support parents who have children with sensory integration disorders by increasing their theoretical as well as practical knowledge. The experience of eating more enjoyable and accessible needs intrinsic motivation, sensory functioning and understanding from a social environment.

There is no doubt that the problem of sensory integration disorders in children is growing, and cooperation between specialists from various fields is needed – doctors, dieticians, psychologists, and therapists. Appropriate diet and medications or supplements can increase the effectiveness of helping children with ASD. Multidisciplinary intervention strategies are needed to minimize food avoidance behaviors of children with sensory integration disorders (e.g. ASD), which may affect their nutritional status as well as cognitive and social-behavioral outcomes.

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The authors declare that they have no conflicts of interest concerning this article.

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ORIGINAL ARTICLE

ASSESSMENT OF PREFERENCES AND FREQUENCY OF MILK AND SELECTED DAIRY PRODUCTS CONSUMPTION BY MOTHERS AND THEIR CHILDREN AGED 1 TO 3 YEARS

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ABSTRACT

Background. Early childhood is a time of developing eating habits and taste preferences, which is most influenced by the family environment. Milk and dairy products play an important role in the diet of post-infant children, as they provide many nutrients that condition the proper growth and development of the young body.

Objective. Assessment of the preferences for milk and selected dairy products and the frequencies of their consumption by mothers and their children aged 1 to 3 years.

Material and Methods. The study was conducted in 2019 in a group of women (n=94) aged 20-40 years who have a child aged 1-3 years and do not exclude milk and dairy products from their own or their child's diet. The study applied the Computer-Assisted Web Interview (CAWI) method using a survey including food frequency questionnaire (FFQ) developed on the basis of the Dietary Habits and Nutrition Beliefs Questionnaire (KomPAN) for research on dietary views and habits and questions about the preferences of mothers and their children regarding milk and selected dairy products.

Results. Products that were preferred by mothers and children were also consumed significantly more often in both groups ($p \leq 0.05$). Preferences for selected dairy products in the group of mothers and their children were also similar. The most popular products in both groups were: yoghurt, cottage cheese and rennet cheese, with the latter being preferred by significantly more mothers than children ($p<0.001$). The frequency of consumption of selected dairy products among women and children was similar, namely the most frequently consumed dairy products were: milk, yoghurt and rennet cheese, and the least frequently consumed were buttermilk and kefir.

Conclusions. Considering the achieved results, it seems reasonable to conduct activities encouraging the consumption of fermented milk products, especially kefir and buttermilk, which have many beneficial health properties and which are the least preferred by mothers and their children aged 1-3 years, and therefore the least consumed.

Keywords: *nutrition, women, children aged 1-3 years, milk and dairy products, preferences, frequency of consumption*

INTRODUCTION

The nutrition of children in early childhood is of great importance due to the possible risk of nutritional deficiencies and excesses, or nutritional disorders that contribute to the development of various diseases, e.g. obesity, and in later years of life also type 2 diabetes and cardiovascular diseases [1]. A balanced diet of children in this period plays an important role, with particular attention paid to the appropriate energy and nutritional value of the diet [2], the appropriate number of meals and the share of different product groups in them [3]. One of such groups is milk and dairy products, such as: yoghurts, kefirs, buttermilk, cottage cheese and rennet cheese. They are a source of high-quality protein, many minerals: calcium, phosphorus, magnesium, zinc, iodine, potassium, as well as vitamins: A, D, B_2 and B_{12}. Milk and dairy products should be present in the daily diet of small children [3]. Insufficient calcium and vitamin D intake during childhood can lead to bone mineralization disorders, increase the risk of fractures and rickets, and prevent the achievement of maximum peak bone mass later in life. It also disrupts the functioning of many systems: muscular, nervous, immune, increasing the risk of developing autoimmune diseases [4, 5, 6].

In the case of protein, both deficiency and excess of this ingredient in the diet of small children can be harmful to health, because too little protein intake leads to growth and development disorders, while excessive protein intake increases the risk of overweight and obesity [7]. The way children are fed in the first three years of life, and especially in the post-infancy period, is also of great importance in

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shaping their proper eating habits, which is mainly influenced by parents and their eating habits [8]. Nutritional preferences developed in the first years of a child's life, both favorable and unfavorable ones, tend to persist in the future, also affecting the way they eat, and thus their health in adulthood [9]. Considering the role of the family environment in shaping nutritional behaviors and the importance of milk and dairy products in the development of a small child's body, as well as the relatively small number of Polish studies in this area, such an assessment was undertaken in the present study. The aim of this study was to assess the preferences for milk and dairy products and the frequencies of their consumption by mothers and their children aged 1 to 3 years.

MATERIAL AND METHODS

This study was conducted from January to March 2019 using the CAWI method, using an anonymous Google form survey, the link to which was distributed among mothers of children aged 1 to 3 years by placing it on selected social networking sites and internet forums intended for parents. The method of recruiting participants to the study was the snowball method (non-random sampling) [10]. The criteria for inclusion in the study were: women's age over 18 years, having a child aged 1 to 3 years, no diseases and food allergies/intolerances to cow's milk proteins in the respondent and/or the child, following a standard diet without excluding milk and dairy products from their own and/or the child's diet. The exclusion criteria for the study were having more than one child aged 1-3 years in order to exclude the influence of siblings on the child's preferences and to make it easier for the mother to determine the child's preferences, which could be problematic with a larger number of children, as well as using a dairy-free elimination diet. The study involved 94 women with an average age of 29.6±4.4 years. The research tool was a FFQ containing questions about the frequency of milk and dairy product consumption by mothers and their children, developed on the basis of the KomPAN questionnaire for research on dietary views and habits [11], which was expanded to include questions about milk and selected dairy product preferences (kefir, buttermilk, yoghurt, cottage cheese and rennet cheese). Mothers determined their preferences and the preferences of their children by selecting one of three response categories: "I like it very much", "I like it" and "I don't like it". The survey metrics included questions about: age, education, place of residence and self-assessment of physical activity level, including high, medium and low levels based on recommendations on physical activity for adults (aged 18-64) [12]. High/medium level was defined as more/less than 2.5 hours of moderate intensity activity per week, e.g. brisk walking, swimming or gardening or more/less than 1.25 hours of high intensity activity, e.g. aerobics, running, fast cycling, while low level was defined as no physical activity or occasional physical activity, e.g. sometimes short walk. The metrics also included questions about anthropometric data of women and their children, such as body weight and height. On this basis, the nutritional status of mothers and children was assessed using the Body Mass Index (BMI). The following criteria for mothers' BMI were used: underweight: less than 18.5 kg/m^2; normal body weight: 18.5-24.9 kg/m^2; overweight: 25.0-29.9 kg/m^2 and obesity ≥30.0 kg/m^2 [13]. The BMI values calculated for children were referred to the percentile charts [14] and the following criteria for assessing nutritional status were adopted: underweight: below the 5th percentile; normal body weight: 5th-85th percentile; overweight: 85th–95th percentile and obesity above the 95th percentile [15].

Statistical analysis was performed using Statistica 13.3 software (TIBCO Software Inc., Palo Alto, California, USA). Pearson's *Chi*^{2} test was applied to determine statistically significant differences, and results for which $p \leq 0.05$ were considered statistically significant. Due to the small size of the study group (n=94) and as many as 5 possible answers regarding the frequency of consumption in the KomPAN questionnaire, 3 categories were created for the statistical analysis of the results: "1-3 times a month or less often" (originally including the categories: never and 1-3 times a month), "from 1 to several times a week" (including the categories: 1 time a week and several times a week), "from 1 to several times a day" (including the categories: 1 time a day and several times a day).

RESULTS

The characteristics of the study group of women and their children are presented in Table 1. More than half of the women participating in the study were aged 25-34, declared higher education and lived in cities with 20,000 to over 100,000 inhabitants, and were characterized by normal body weight and low level of physical activity. More than half of the group of children were girls, children aged 1 to 2 years, characterized by normal body weight.

Table 2 presents the frequencies of milk and selected dairy products consumption by mothers and children. The frequencies of milk and selected dairy products consumption among women and children was similar, the most frequently consumed dairy products were milk, yoghurt and rennet cheese, and the least frequently buttermilk and kefir. Daily milk consumption was declared by almost half of women and children, yoghurts and cheeses were consumed

Table 1. Characteristics of the study group of women and their children

Characteristics of women		% of respondents
Age*	20-24 years	13
	25-29 years	36
	30-34 years	38
	35-39 years	11
	40-44 years	2
Education	Elementary/vocational	0
	Secondary	29
	Higher	71
Place of residence	Village	11
	City <20k inhabitants	18
	City 20-100k inhabitants	25
	City >100k inhabitants	46
BMI	Underweight	10
	Normal body weight	65
	Overweight	20
	Obesity	5
Self-assessment of physical activity	Low level	59
	Medium level	35
	High level	6
Characteristics of children		% of children
Age	12-24 months	71
	25-36 months	29
Sex	Girl	51
	Boy	49
BMI	Underweight	15
	Normal body weight	76
	Overweight	5
	Obesity	4

* Age categories based on the WHO classification [16]; BMI – body mass index (assessment criteria described in the methodology)

most often from one to several times a week, with over half of women and children consuming yoghurts and cottage cheese from one to several times a week, and in the case of rennet cheese, such frequency of consumption concerned almost 60% of women and half of children. The largest percentage of women and children (over ¾ of the group) consumed kefir and buttermilk the least frequently, namely 1-3 times a month or less.

Table 3 presents the preferences for milk and selected dairy products in the group of mothers and children. The most preferred products in both the group of mothers and children were: yoghurt, milk, cottage cheese and rennet cheese. In both groups, preferences were similar, but it was shown that significantly more mothers than children preferred rennet cheese (p=0.0001). In addition, a larger percentage of women declared that they liked kefir but did not like buttermilk, and in the group of children, preferences

Table 2. Frequency of consumption of milk and selected dairy products by mothers and children

Product	Frequency of consumption		
	1-3 times a month or less	from 1 to several times a week	from 1 to several times a day
	Mothers (%)		
Milk	25	29	46
Kefir	80	19	1
Buttermilk	88	12	0
Yoghurt	25	64	11
Cottage cheese	44	53	3
Rennet cheese	21	59	20
Product	Children (%)		
Milk	29	24	47
Kefir	83	16	1
Buttermilk	88	12	0
Yoghurt	20	53	27
Cottage cheese	42	52	6
Rennet cheese	38	48	14

Table 3. Preferences for milk and selected dairy products in the group of mothers and children

Product	Preferences	Mothers (%)	Children (%)	p*
Milk	likes it very much	18	21	NS
	likes it	65	63	
	doesn't like it	17	16	
Kefir	likes it very much	12	6	NS
	likes it	48	41	
	doesn't like it	40	53	
Buttermilk	likes it very much	12	4	NS
	likes it	40	39	
	doesn't like it	48	57	
Yoghurt	likes it very much	28	33	NS
	likes it	69	63	
	doesn't like it	3	4	
Cottage cheese	likes it very much	23	15	NS
	likes it	68	69	
	doesn't like it	9	16	
Rennet cheese	likes it very much	32	18	0.0001
	likes it	67	61	
	doesn't like it	1	21	

*Pearson Chi^2 test; NS – statistically insignificant, p>0.05

for both products were similar, more than half of the children did not like both kefir and buttermilk.

Table 4 presents the preferences of children for milk and selected dairy products depending on the preferences of mothers. Statistical analysis showed that children of mothers who declared that they liked milk, yoghurt, cottage cheese and rennet cheese also preferred these products ($p<0.001$). On the other hand, children of mothers who declared that they did not like kefir and buttermilk did not prefer these products either ($p=0.0000$).

Table 5 presents the frequency of consumption of milk and selected dairy products by children depending on their preferences. Statistical analysis showed that those dairy products that were preferred by children were also consumed more often by them. A significantly higher percentage of children who preferred milk consumed it every day ($p=0.0007$), while yoghurt and both types of cheese from one to several times a week, compared to children who did not like these products. At the same time, more than half of children who did not like buttermilk and kefir consumed these products 1-3 times a month or less often. It is worth noting that about 30% of children, despite liking these products, consumed them rarely.

Table 6 presents the frequencies of milk and selected dairy products consumed by mothers depending on

Table 4. Preferences for milk and selected dairy products in children depending on mothers' preferences

Product	Mothers' preferences	Children's preferences (%)			p*
		likes it very much	likes	doesn't like it	
Milk	likes it very much	12	6	0	0.0000
	likes it	9	49	7	
	doesn't like it	1	7	9	
Kefir	likes it very much	6	1	4	0.0000
	likes it	0	28	20	
	doesn't like it	0	12	29	
Buttermilk	likes it very much	4	5	2	0.0000
	likes it	0	25	16	
	doesn't like it	0	10	38	
Yoghurt	likes it very much	24	4	0	0.0000
	likes it	10	56	3	
	doesn't like it	0	2	1	
Cottage cheese	likes it very much	11	11	2	0.0002
	likes it	3	52	13	
	doesn't like it	1	6	1	
Rennet cheese	likes it very much	14	12	6	0.0000
	likes it	3	49	15	
	doesn't like it	1	0	0	

*Pearson Chi^2 test

Table 5. Frequency of milk and selected dairy products consumption by children and their preferences

Children's preferences	Frequency of food consumption by children (%)			p*
	1-3 times a month or less	from 1 to several times a week	from 1 to several times a day	
Milk				
Likes it very much	1	2	18	0.0007
Likes it	20	16	27	
Doesn't like it	8	6	2	
Kefir				
Likes it very much	1	5	0	0.0000
Likes it	29	11	1	
Doesn't like it	53	0	0	
Buttermilk				
Likes it very much	0	4	0	0.0000
Likes it	32	8	0	
Doesn't like it	56	0	0	
Yoghurt				
Likes it very much	0	18	15	0.0004
Likes it	17	34	12	
Doesn't like it	3	1	0	
Cottage cheese				
Likes it very much	1	11	3	0.0000
Likes it	24	42	3	
Doesn't like it	16	0	0	
Rennet cheese				
Likes it very much	0	12	6	0.0000
Likes it	17	36	8	
Doesn't like it	21	0	0	

*Pearson Chi^2 test

their preferences. In the group of mothers, it was shown that the preference for milk and some dairy products had a significant impact on the frequency of their consumption. A significantly higher percentage of mothers who preferred milk consumed it from one to several times a day (p=0.0003), yoghurt and cottage cheese from one to several times a day (p=0.0007 and p=0.0081, respectively) than mothers who did not prefer these products. In turn, significantly more women who declared that they did not like buttermilk and kefir consumed these products from one to three times a month or less often (in both cases p=0.0000) than women who rated these products as liked. It should be noted that about 1/3 of women, although they declared that they preferred products such as cottage cheese, kefir or buttermilk, consumed them with the lowest frequency.

Table 7 presents the frequency of milk and selected dairy products consumed by children depending on their mothers' preferences. It was shown that mothers' preferences for milk and selected dairy products had a significant impact on the frequency of consumption

Table 6. Frequency of milk and selected dairy product consumption by mothers and their preferences

Mothers' preferences	Frequency of product consumption by mothers (%)			p*
	1-3 times a month or less	from 1 to several times a week	from 1 to several times a day	
Milk				
Likes it very much	0	4	14	0.0003
Likes it	15	20	30	
Doesn't like it	11	4	2	
Kefir				
Likes it very much	4	8	0	0.0000
Likes it	35	12	1	
Doesn't like it	40	0	0	
Buttermilk				
Likes it very much	6	5	0	0.0000
Likes it	34	7	0	
Doesn't like it	48	0	0	
Yoghurt				
Likes it very much	0	24	4	0.0007
Likes it	22	41	6	
Doesn't like it	3	0	0	
Cottage cheese				
Likes it very much	2	19	2	0.0081
Likes it	33	34	1	
Doesn't like it	5	3	1	
Rennet cheese				
Likes it very much	1	11	6	NS
Likes it	14	35	12	
Doesn't like it	6	13	2	

*Pearson Chi^2 test; NS – statistically insignificant, p>0.05

Table 7. Frequency of consumption of selected milk and dairy products by children and mothers' preferences

Mothers' preferences	Frequency of food consumption by children (%)			p*
	1-3 times a month or less	from 1 to several times a week	from 1 to several times a day	
Milk				
Likes it very much	2	3	13	NS
Likes it	21	18	25	
Doesn't like it	5	3	9	
Kefir				
Likes it very much	7	5	0	0.0388
Likes	39	8	1	
Doesn't like it	37	3	0	
Buttermilk				
Likes it very much	5	7	0	0.0001
Likes	36	4	0	
Doesn't like it	46	2	0	
Yoghurt				
Likes it very much	0	15	13	0.0039
Likes it	18	37	14	
Doesn't like it	2	1	0	
Cottage cheese				
Likes it very much	4	17	2	NS
Likes it	33	32	3	
Doesn't like it	4	3	1	
Rennet cheese				
Likes it very much	9	16	7	0.0216
Likes it	30	32	5	
Doesn't like it	0	0	1	

*Pearson Chi^2 test; NS – statistically insignificant, p>0.05

of these products by children. A significantly higher percentage of children of mothers who declared that they preferred yoghurt or rennet cheese consumed these products from one to several times a week (p=0.0039 and p=0.0216, respectively) than children of mothers who did not prefer these products. Moreover, significantly more children of mothers who did not like buttermilk consumed this product less often than children of women who preferred this product (p=0.0001). The case was different for kefir, because significantly more children of mothers who liked kefir consumed it less often, compared to children of mothers who declared that they did not like this product (p=0.0388).

DISCUSSION

The way of feeding in early childhood is crucial for the proper growth and development of a young organism. In recent years, the problem of the growing percentage of smaller and smaller children with excessive body weight has been emphasized; according to WHO data, in Europe the incidence of overweight and obesity in children under 5 years of age ranges from 1 to 29% [17]. In our study, 76% of children were characterized by normal body weight, which is consistent with the results of other Polish studies, namely 71% of the examined children aged 1-3 years from the Wielkopolska region were also characterized by normal body weight [18], similarly 68% of children aged 1-3 years in the Pitnuts 2016 study conducted by Weker et al. [19]. In our own study, excess body weight was found in less than 10% of children, also 10% of children with excess body weight were found in the Pitnuts 2016 study [19], while in the Wojtyła-Buciora study [18] it was 13%. Additionally, it is worth noting that in our study 15% of children were characterized by too low body weight, the same percentage of underweight children was found in the Wielkopolska region [18], while in the Pitnuts 2016 study, too low body weight was found in less than 5% of children [19]. The discrepancies are most likely related to different approaches to the criteria for classifying the nutritional status of small children, as well as the different numbers of the studied groups, including the fact that the Pitnuts study was conducted in a representative group of children, while in this study the studied group was not representative.

Milk and dairy products should be an important part of the diet of small children, as they provide many nutrients that are necessary for the proper growth and development of a young organism. In this study, most children consumed milk and selected dairy products once or several times a day, which corresponds to the results obtained in a study conducted among children aged 2 and 3 from rural areas [20]. On the other hand, the most frequently consumed dairy products in the group of children were milk, yoghurt and rennet cheese, and the least frequently buttermilk and kefir. Similarly, children aged 1-3 from the Wielkopolska region also most frequently consumed milk, yoghurt and cheese, and only 1% consumed buttermilk or kefir [18]. Our own results and those of other authors indicate a very small share of fermented milk products such as buttermilk and kefir in the diet of children, which in this study were consumed by over 80% of children 1-3 times a month or less, while less than 30% of children consumed yoghurt from one to several times a day, which means that these children fulfilled the recommendations that one of the two portions of milk products daily should be fermented milk products [3]. Also, the mothers' declarations regarding the frequency of consumption of fermented products indicate the problem of their too low consumption in this group, while the frequency of consumption of selected dairy products was similar to the consumption of these products in the group of children. Less than half of the respondents declared that they consumed milk from one to several times a day, which does not differ significantly from the results of other studies conducted among young adults, as almost 40% of female students of Wrocław universities consumed milk at least once a day, and every sixth of them declared consumption several times a day [21]. Other Polish studies also showed that students most often consume milk, followed by yoghurt and ripened cheese [22, 23].

Not only the frequency of consuming dairy products, but also the preferences for selected dairy products were similar in both the group of mothers and children. Women declared that they preferred yoghurts, cheeses and milk the most, and buttermilk the least, similarly in other Polish studies it was noted that in the group of young women the most liked dairy products were yoghurts and rennet cheese, and the least buttermilk [24]. In the group of Poznań female students the most preferred dairy products were cottage cheese and maturing cheese, fermented drinks and milk, and the least kefir, buttermilk, smoked cheeses and flavoured cottage cheeses [25]. Also in the group of students the most preferred were yoghurts and rennet cheeses [23]. On the other hand, among foreign consumers the most preferred were yoghurts, milk and cheeses [26]. Interestingly, yoghurt is indicated as the most liked product by teenagers [27], as well as children from younger classes [28]. Children aged 1-3 years participating in this study, in the opinion of their mothers, preferred cottage cheese, yoghurt and milk the most, and kefir and buttermilk the least. In the available scientific literature, there is a lack of studies on the preferences of milk products among small children, however, other authors indicate that kefir

and buttermilk are among the least preferred milk products in different age groups, both in preschool children [29], adolescents [27], and adults [24].

One of the most important factors influencing food choice is taste [30], and dairy products are also consumed for their taste [31]. Among them, yoghurt is the product most accepted by consumers due to not only its taste, but also its nutritional value and health-promoting properties [31]. Although our study did not ask about product features that influence preferences or purchasing decisions, the study conducted by Świąder et al. [23] indicates that for young adults, the important features when choosing a product are: composition, consistency, appearance and taste. A different production method causes kefir to have a specific, slightly fermented and sour taste, which is caused by volatile compounds produced by microorganisms present in kefir grains [32]. It can be assumed that the slightly sour taste of kefir makes this product less acceptable than other milk products, e.g. yoghurt. Additionally, yoghurt can be used as an ingredient in various meals and dishes, while kefir as an ingredient in various dishes seems to be much less common. However, considering that kefir is a probiotic product with a broad spectrum of health-promoting effects, including antibacterial and immunomodulatory effects, as well as improving lactose digestion [33], its inclusion in the daily diet of small children is very important and for this reason it seems justified to conduct nutritional education among parents.

In our own study, it was noted that selected dairy products preferred by mothers were similarly preferred by their children, which confirms the important role of the family environment in shaping children's taste preferences [34]. In the case of the smallest children, parents are fully responsible for their diet, having a direct influence on the composition of the child's daily diet, but additionally they can also influence children's eating behaviours by modelling them [9]. In the available Polish literature, there is a lack of studies on dairy product preferences among children aged 1 to 3 years, while a study conducted in a group of preschool children and their mothers showed that there is a relationship between mothers' taste preferences and their children's preferences for selected dairy products, although this concerned a greater preference for sweet dairy products compared to natural products [29]. In turn, Japanese researchers showed a relationship between mothers' nutritional preferences and the nutritional preferences of children aged 3 to 5 years, but in relation to food in general [35]. Interestingly, they demonstrated a relationship between mothers' preferences from their childhood and current dietary habits and the dietary habits of their children, assuming that the dietary preferences of mothers may be inherited by children. The researchers suggested that children's dietary preferences can be modified by providing them with a variety of products, regardless of the mothers' likes and dislikes [35]. Considering that parents' dietary practices and their consumption of dairy products may shape the consumption of dairy products in children [34], it would be advisable to provide parents with nutritional education on the health benefits of regular consumption of dairy products, but in parallel with educational activities for preschool children, because this is the time when developing healthy dietary habits will be most effective [36]. Additionally, as indicated by the results of studies conducted among adolescents, the frequency of pro-health dietary behaviours decreases with age [37], which is why nutritional education for preschool children is particularly important.

Limitations of the study

Among the factors limiting the study, it is worth mentioning: the small size of the group (mothers/children), which makes it impossible to generalize the results to the population; the use of the FFQ method in assessing the consumption of milk and dairy products (mothers/children), which may result in overestimating the frequency of consumption by respondents; self-reporting of anthropometric data by mothers (data regarding mothers/children), which is subject to underestimation/overestimation error.

CONCLUSIONS

Taking into account the obtained results, it seems justified to conduct activities encouraging the consumption of fermented milk products, especially kefir and buttermilk, which have many beneficial health properties and which are the least preferred by mothers and their children aged 1-3 years, and therefore the least frequently consumed.

Disclosure conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ORIGINAL ARTICLE

DO CHILDREN AND ADOLESCENTS WITH EXCESS BODY WEIGHT AND DYSLIPIDEMIA CONSUME ENOUGH VEGETABLES AND FRUITS BEFORE PARTICIPATING IN THE NUTRITIONAL INTERVENTION PROGRAM?

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ABSTRACT

Background. The recommended intake of vegetables and fruits is an important element of dietotherapy in the treatment of excess body weight and dyslipidemia in children and adolescents.

Objective. Assessment of vegetables and fruits consumption by children and adolescents with excess body weight and diagnosed dyslipidemia before participating in the nutritional intervention program.

Material and Methods. The study included 64 children and adolescents (44 boys and 20 girls) aged 8-16 with overweight or obesity and dyslipidemia. These were patients of the Children's Memorial Health Institute in Warsaw referred by a pediatrician to participate in the nutritional intervention program. Vegetables and fruits consumption was estimated based on a 3-day current food record and the validated Food Frequency Questionnaire (FFQ-6).

Results. The average consumption of total vegetables and fruits was 593±311 g, including 286±163 g of vegetables and 306±199 g of fruits (no differences in the groups with overweight and obesity, $p \geq 0.05$). Compared to participants with overweight, patients with obesity consumed more vegetables per 1000 kcal of diet ($p=0.034$). In total, 41% of children and adolescents had a greater share of vegetables than fruits in meeting the recommendations (no differences between groups of participants with overweight or obesity, $p \geq 0.05$). About half of the participants ate vegetables and fruits less than once a day. Raw vegetables and fruits were chosen more often than processed ones or juices.

Conclusions. Only 16% of children and adolescents with excess body weight and dyslipidemia before participating in the nutritional intervention program did not consume the recommended amounts of vegetables and fruits set at a minimum of 400 g. In nutritional education, special attention should be paid to promoting the consumption of several portions of vegetables and fruits every day, as well as their appropriate proportions.

Keywords: *vegetables, fruits, childhood obesity, adolescents, dyslipidemia, diet*

INTRODUCTION

Proper consumption of vegetables and fruits is one of the basic elements of a healthy, balanced diet, both in dietary prevention and dietary therapy of diet-related diseases [1]. Experts from the World Health Organization (WHO) recommend eating at least 400 g of vegetables and fruits a day (excluding potatoes, sweet potatoes, cassava and other starchy roots) [2]. Healthy Eating Recommendations for the Polish population also specify that there should be more vegetables than fruits [3]. Vegetables and fruits are a source of dietary fiber, antioxidant vitamins, minerals and many bioactive compounds [4]. Additionally, they provide a greater feeling of satiety with lower calorie content compared to other products, which helps control body weight, provided they are eaten instead of energy-dense foods [5]. Regularly consuming the recommended amount vegetables and fruits reduces the risk of many non-communicable diseases, including obesity, cardiovascular diseases, hypertension, diabetes and some cancers, as well as the risk of all-cause mortality [6-8]. Experts from the European Food Safety Authority (EFSA) indicate that increasing vegetables and fruits consumption to 5 servings per day (or 3 servings of vegetables and 2 servings of fruits) reduces the risk of all-cause mortality by 3-5% for each additional serving (approximately 80 g/day) [9]. Low consumption of vegetables and fruits by children and adolescents is considered one of the main nutritional mistakes in this age group [10]. Improper eating habits may result

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in health consequences already in childhood, but they also persist throughout life. That is why it is so important to develop healthy eating habits from early childhood, including appropriate consumption of vegetables and fruits [11].

The aim of this study was to assess the consumption of vegetables and fruits by children and adolescents with excess body weight and diagnosed dyslipidemia before participating in the nutritional intervention program.

MATERIAL AND METHODS

The study was conducted in 2019-2020 among 64 patients (including 44 boys and 20 girls) aged 8-16 diagnosed with overweight or obesity and dyslipidemia, living in Poland, in the Mazowieckie Voivodship. These were patients of the Children's Memorial Health Institute in Warsaw referred by a pediatrician to participate in the nutritional intervention program. Body weight was assessed based on body mass index (BMI) and compared with the BMI percentile charts in children and adolescents in Poland [12]. Overweight was defined as a BMI between 85th and 95th percentile, and obesity as >95th percentile for age and gender, as defined by the International Obesity Task Force (IOTF) [13]. Dyslipidemia was defined as the presence of at least 1 lipid abnormality, such as high total cholesterol (TC), high low-density lipoprotein (LDL-C), high triglycerides (TG), or low high-density lipoprotein cholesterol (HDL-C) according to the American College of Cardiology [14].

Patients were qualified to participate in the nutritional intervention program by a pediatrician based on a medical interview. Data regarding current and habitual food intake were collected and analyzed by a dietitian before the start of the program. The dietitian also provided dietary counseling and performed anthropometric measurements. To assess current food intake, a 3-day food record was used, with patients receiving a template and instructions for completing it. They were asked to carefully record all food they ate and drank on 2 weekdays and 1 day off from school before they began the nutritional intervention. On this basis, the amount (in grams) and sources of vegetables and fruits consumption, including raw products, processed products (e.g. cooked, fermented, canned) and juices, were analyzed [15]. The amounts of processed vegetables/fruits and juices were converted into raw products using appropriate conversion factors [16]. Then, the intake values were compared to the WHO recommendations set as a minimum 400 g of vegetables and fruits per day [2]. The amount of vegetables and fruits consumed was additionally presented per 1000 kcal of diet. Calculations of energy value from the food records were made by the dietitian with the use of a table of nutritional value of food products and dishes [17]. Data on habitual food intake of products from 8 food groups, including vegetables and fruits, were also collected using the validated Food Frequency Questionnaire (FFQ-6) [18].

The study protocol was approved by the Ethics Committee of the Faculty of Human Nutrition and Consumer Science, Warsaw University of Life Sciences WULS, Poland (10p/2017, 17 May 2017). More details about the design and study are provided in the study protocol [19].

Statistical analysis

All statistical analyses were conducted using Statistica version 13.1 (Copyright©StatSoft, Inc., 1984–2014, Cracow, Poland).

The Shapiro-Wilk test was used to assess the normality of distributions. Nonparametric tests were used in statistical analyses due to the lack of normal distribution in groups. The Mann-Whitney U test was used to compare the amount of vegetables and fruits consumed by patients with overweight and patients with obesity. All quantitative data are expressed as mean ± standard deviation (SD). The *Chi*-squared test was used to examine the relationship between qualitative variables. Statistical tests used for analysis are described separately in each data table. For all tests, $p<0.05$ was considered significant.

RESULTS

The average age of the study participants was 12.78±2.65 years. Patients with overweight constituted 44% (n=28) of the respondents, and 56% (n=36) were diagnosed with obesity. The average consumption of vegetables and fruits from all sources in the total study group was 593±311 g per day. Table 1 shows the average consumption of vegetables and fruits in two groups of participants: patients with overweight and patients with obesity. Consumption was expressed separately for vegetables and fruits, together and per 1000 kcal of diet. No statistically significant differences were observed in the grams of vegetables and fruits consumed (for the whole diet) separately and together between patients with overweight and obesity ($p\geq0.05$). Significant differences ($p<0.05$) were noted after calculating the consumption per 1000 kcal of diet. Children and adolescents with obesity consumed more vegetables compared to overweight people (Table 1).

To assess the frequency of vegetables and fruits consumption, the criterion of eating them at least once a day or less often was adopted (Table 2). It was shown that vegetables were consumed at least once a day by only half of the respondents. Similarly in the case of fruits – 4 out of 10 patients included it in their diet at least once a day. No significant differences were observed

in the frequency of vegetables and fruits consumption between patients with overweight and obesity. The vegetables most frequently chosen by children and adolescents were tomatoes and cucumbers, followed by root vegetables and leafy vegetables. Among the fruits, these were primarily apples and pears, followed by berries and bananas.

Table 3 presents data on the consumption of different types of vegetables and fruits, including raw, processed and juices. For both vegetables and fruits,

Table 1. Consumption of vegetables and fruits by children and adolescents with overweight or obesity [mean ± SD]

Products \ Patients	Total (n=64)	Patients with overweight (n=28)	Patients with obesity (n=36)	p-value (Mann–Whitney U test)
Vegetables [g]	286±163	235±106	327±188	ns
Fruits [g]	306±199	305±170	308±223	ns
Vegetables and fruits [g]	593±311	540±177	635±382	ns
Vegetables per 1000 kcal of diet [g]	134±71	118±67	147±71	0.034
Fruits per 1000 kcal of diet [g]	145±97	147±71	143±114	ns
Vegetables and fruits per 1000 kcal of diet [g]	279±142	265±89	290±172	ns

ns – not significant (p≥0.05)

Table 2. Frequency of vegetables and fruits consumption by children and adolescents with overweight or obesity [% of participants]

Type of product \ Patients		Total (n=64)	Patients with overweight (n=28)	Patients with obesity (n=36)	p-value (*Chi*-squared test)
Vegetables	Less than once a day	50	43	56	ns
	At least 1 time a day	50	57	44	
Fruits	Less than once a day	59	50	67	ns
	At least 1 time a day	41	50	33	

ns – not significant (p≥0.05)

Table 3. Types of vegetables and fruits consumed by children and adolescents with overweight or obesity [mean ± SD]

Type of products \ Patients	Total (n=64)	Patients with overweight (n=28)	Patients with obesity (n=36)	p-value (Mann–Whitney U test)
Raw vegetables [g]	157±107	96±94	205±92	<0.001
Processed vegetables [g]	120±135	134±114	110±149	0.032
Vegetable juices [g]	9±30	5±18	13±37	ns
Raw fruits [g]	236±183	194±76	263±234	ns
Processed fruits [g]	16±57	10±23	21±73	ns
Fruit juices [g]	62±105	101±134	32±64	0.026

ns – not significant (p≥0.05)

Table 4. Implementation of recommendations regarding the consumption of vegetables and fruits [% of participants]

Recommendations \ Patients		Total (n=64)	Patients with overweight (n=28)	Patients with obesity (n=36)	p-value (*Chi*-squared test)
Consumption of at least 400 g of vegetables and fruits per day	Yes	84	93	78	ns
	No	16	7	22	
Greater participation in the implementation of recommendations	Vegetables	41	64	44	ns
	Fruits	59	36	56	

ns – not significant (p≥0.05)

patients consumed most raw products (58% and 75% of total intake, respectively). Among all vegetables, the share of processed products was almost 40% for the entire study group. Compared to patients with overweight, children and adolescents with obesity consumed more than twice as much raw vegetables and 2 times less processed vegetables (statistically significant differences). Significantly higher (over 3 times) consumption by participants with overweight was recorded for fruit juices ($p<0.05$). In the case of vegetable juices, raw fruits and processed fruits, there were no statistically significant differences in their consumption between children and adolescents with overweight and obesity ($p\geq0.05$).

Comparison of consumption with the recommendations showed that 8 out of 10 respondents consumed at least 400 g of vegetables and fruit per day (Table 4). In total, 41% of patients implemented the recommendations with a greater participation of vegetables than fruits, with no significant differences between children and adolescents with overweight and obesity ($p\geq0.05$).

DISCUSSION

Consuming the recommended amount of vegetables and fruits is the main element of dietary recommendations necessary to maintain health, as well as used in the prevention and treatment of diet-related diseases [20]. They should be eaten every day and added to every meal, preferably raw, but also in the form of soups, salads or cocktails. Our study shows that 84% of children and adolescents with excess body weight and dyslipidemia met the WHO recommendations for vegetables and fruits consumption set at a minimum of 400 g per day. It also did not differ significantly between patients with overweight and obesity. However, analysis of the frequency of consumption showed that about half of the patients consumed vegetables and fruits less than once a day. Insufficient consumption of vegetables and fruits is also observed in children and adolescents from other age groups. It was noted among primary and lower secondary school students in Poland [21]. It was also shown that among lower secondary school students, 62% of boys and 56% of girls did not eat fruits every day, and 65% of boys and 58% of girls did not eat vegetables every day. Although Hetmańczyk et al. [22] showed that most children aged 10-15 ate vegetables and fruits at least once a day (94% and 95% of respondents, respectively). The problem of insufficient consumption of vegetables and fruits is also observed among secondary school students in Poland in other study [23]. The authors showed that less than half of young people confirmed eating vegetables and fruits several times a day. Similarly, among students aged 16-19, 69% and 67% of respondents, respectively, consumed vegetables and fruits less frequently than every day [24]. Low intake of vegetables and fruits is also reported among younger children. In preschoolers, it was shown that almost 9 out of 10 children did not eat enough vegetables, and every third child did not eat enough fruits [25]. Insufficient consumption of vegetables and fruits is also observed among children and adolescents from other countries. The Health Behavior in School-aged Children (HBSC) conducted in 2021/2022 in 44 countries and regions shows that only 38% of students aged 11-15 consume vegetables and fruits every day, with higher consumption among girls. Moreover, it was shown that half of the surveyed adolescents did not eat vegetables or fruits every day [10], which was consistent with our results. Similarly, low consumption of vegetables and fruits is observed in the adult population. Analysis of vegetables consumption data from 162 countries shows that in 88% of countries their intake was below the recommended level of ≥240 g/day [26]. Many researchers also point out that the consumption of vegetables and fruits decreases with age of children [21, 25, 27]. This is disturbing because the older children and adolescents become, the greater their ability to make independent decisions regarding food choices. This may result from incorrect developing eating habits and indicate a great need for education both among children of all ages and their parents [28].

Recommendations for the consumption of vegetables and fruits define their total amount, generally indicating that there should be more vegetables [2, 3]. There is no consistency in the recommendations of different countries and scientific societies regarding the ideal proportion of vegetables and fruits. In our study, children and adolescents consumed a similar amount of vegetables and fruits (286±163 g and 306±199 g, respectively). This differs from the Healthy Eating Recommendations for the Polish population, which indicate that the diet should include more vegetables than fruits due to their lower content of simple sugars [3]. For many years, WHO has been drawing attention to the high intake of sugars in the diet, especially in children, which is one of the risk factors for the development of diet-related diseases [29]. According to the guidelines of the Committee of Human Nutrition Science of the Polish Academy of Sciences children aged 7-9 should consume 350 g of vegetables and 250 g of fruits per day [30]. In turn, the 2021 recommendations of the European Society of Cardiology regarding nutrition in the prevention of cardiovascular diseases [31] include information that it is recommended to consume ≥200 g of fruits per day (≥2-3 servings) and ≥200 g of vegetables per day (≥2-3 servings), as shown in this study. Different proportions have been established for hospital patients – it is

recommended to eat 430 g of vegetables and 300 g of fruits per day [32]. However, these recommendations were issued much earlier and, according to many specialists, they are difficult to implement.

Vegetables and fruits are a source of many valuable nutrients, but their content largely depends on the degree of processing of the product. Fresh vegetables and fruits are characterized by a larger volume and lower energy value compared to other products [5]. For this reason, they are especially important in ensuring satiety after a meal while providing fewer calories [33]. It is most recommended to eat raw vegetables and fruits due to the highest nutritional value [9]. In our study, most vegetables and fruits consumed by children and adolescents were raw. Recommendations in different countries are not consistent as to whether juices and processed vegetables and fruits should be included in the total amount of vegetables and fruits consumed. However, in most countries, these products are included, but it is suggested that they be limited in the diet [9]. According to the recommendations of the American Academy of Pediatrics, a maximum of 1 serving of fruits/vegetables can be replaced with 1 glass of juice in the diet of children and adolescents [34]. Juices are devoid of valuable dietary fiber and contain more simple sugars, which may result in a lack of satiety despite the intake of large amounts of calories [35]. Therefore, recommending them instead of fruits, especially among the pediatric population, is inconsistent with promoting healthy eating habits [34]. A meta-analysis of studies on the effects of regular juice consumption on body weight found that in children, each additional daily serving of 100% fruit juice was associated with an increase in BMI [35]. However, it seems that in adults, their moderate consumption does not increase the risk of obesity, type 2 diabetes or cardiovascular diseases [36].

Although the direct impact of vegetables and fruits consumption on body weight in children and adolescents is not clear, many researchers point to certain relationships. In children aged 6-7 and adolescents aged 13-14, it was observed that consuming vegetables and fruits at least three times a week was associated with a lower BMI compared to participants who declared eating them occasionally or not at all [37]. Among Polish youth aged 13-19, no relationship was observed between vegetables consumption and body weight, but teenagers with obesity most often declared regular fruits consumption [27]. Zalewska et al. [23] noticed that more than half of girls with overweight or obesity ate vegetables several times a day, but significantly less often than those with normal body weight. No such relationship was observed among boys.

Vegetables and fruits are as a source of valuable nutrients with anti-inflammatory effects. Many studies have confirmed that regular consumption of vegetables and fruits reduces the risk of cardiovascular diseases and improve cardiometabolic parameters [26, 38]. Data from epidemiological studies indicate that a diet based on the principles of healthy eating, including a greater consumption of vegetables and fruit, contributes to a lower incidence of cardiovascular events [31]. Study among children and adolescents aged 5-19 years showed that moderate fruits consumption, approximately 150-300 g per day for 6-7 days a week, was associated with a reduced risk of dyslipidemia compared to those consuming fruits for 0-2 days a week [39]. In adolescents, an inverse relationship is also observed between vegetables and fruits consumption and systolic blood pressure, abdominal obesity, triglycerides, high-density lipoprotein cholesterol and metabolic syndrome [40]. The study assessed the consumption of vegetables and fruits among children and adolescents with excess body weight and the resulting dyslipidemia, which is one of the health consequences of excess body weight increasing the risk of cardiometabolic diseases [41].

This study has several limiting factors. First, a small study group that is not representative of the general population. However, it results from the sample size calculated for our intervention study, which included children and adolescents with excess body weight and resulting dyslipidemia. The calculated sample size is representative of our intervention study [19]. Another limiting factor is the research methods used. The 3-day food record method refers to the current food intake, which is only part of the overall diet. Its use carries the risk of inaccurate recording. Therefore, this method may be subject to underestimation or overestimation error. The latter situation seems more likely, especially in the case of healthy products such as vegetables and fruits. Patients participating in the program, perhaps wanting to make a better impression, may have overestimated their usual consumption of these products. The second method of data collection in the study was the use of the FFQ-6 questionnaire. Data collected using this method may be overestimated, and completing the survey is time-consuming and requires a lot of patient involvement. However, it is a proven, repeatable method that gives an overview of the entire diet. The use of two different methods of nutritional assessment (current and retrospective) is intended to verify the collected data and reduce the risk of error. It is worth bearing in mind that the assessment of human consumption is always subject to error, which is the sum of various errors, including those related to the method used, the researcher and the respondent, and accidental ones [42].

CONCLUSIONS

Most children and adolescents with excess body weight and dyslipidemia before participating in the nutritional intervention program consumed enough vegetables and fruits. The average consumption of vegetables and fruits was higher than the amounts recommended by WHO. It is necessary to conduct educational activities aimed at promoting the consumption of several portions of vegetables and fruits every day. While following the recommendations, patients should also pay attention to the share of vegetables and fruits in their diet.

Conflict of interest

The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

FACTORS INFLUENCED SUPPLEMENTS USE IN A CHOSEN GROUP OF CHILDREN

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ABSTRACT

Introduction. Dietary supplements have become a common practice, including among children. It is worth noting that supplementation can have a twofold effect: a pro-health effect – improving the nutritional status of the body, or a harmful effect – increasing the risk of nutrient overdose, such as when several preparations are used simultaneously.

Objective. The aim of the study was to assess the determinants of dietary supplement consumption by children aged 3-10.

Material and Methods. The study used a questionnaire method among parents of 151 children attending kindergarten and elementary schools in the Mazovia Province.

Results. Dietary supplements were used by 54.3% of the children surveyed the year before the study. Women with a university education were significantly more likely to supplement their children than women with a secondary or primary education (60.6% and 42.3%, respectively). More children with normal body weight (58.6%) were given supplements than those with overweight and obesity (27.3%). The vast majority of children (66%) took one supplement daily. Concomitant use of supplements with fortified products was observed in 71.4% of respondents. The decision to use a supplement was mainly made by the parents themselves (62%).

Conclusions. Educating parents about the benefits and risks of using dietary supplements is necessary. The use of such preparations should be consulted with a specialist, i.e., a doctor or dietician. It is worth noting that a well-balanced diet should provide all the nutrients, vitamins, and minerals for the child's proper development.

Keywords: *dietary supplements, vitamins, minerals, school children, preschool children*

INTRODUCTION

A well-balanced diet is one of the most important factors influencing human health. Adequate nutrition during childhood determines normal physical and mental development and the development of good eating habits in the future. The role of parents in shaping children's eating behavior and habits is important. Caregivers, who want their children to receive all the necessary nutrients every day, are increasingly looking for an easy and quick way to provide them. To this end, they are turning to dietary supplements (DS). According to the Food and Nutrition Safety Act of 25 August 2006, a dietary supplement is a foodstuff that is a concentrated source of vitamins or minerals or other substances that have a nutritional or other physiological effect [1]. It should be stressed that the purpose of using these foods is only to supplement the daily diet and not to replace regular meals prepared by the principles of proper nutrition.

Based on epidemiological studies, children and adolescents worldwide, including in Poland, may be at risk of certain nutritional deficiencies, mainly vitamin D [2-4]. Therefore, according to the recommendations of the Polish multidisciplinary group, it is mandatory to supplement with vitamin D_3 at a dose of 600-1000 IU/d (15-25 μg) for children aged 2-10 years and 800-2000 UI/d (20-50 μg) for adolescents and adults throughout the year [5].

The use of dietary supplements has become very popular around the world [6-8], as well as in Poland [9, 10], so the market for these foods is growing rapidly.

Manufacturers are offering an increasing number of preparations exclusively for children, which, in addition to nutrients, contain additional substances in their composition, i.e. sweetening agents e.g. sucrose, fructose, honey, molasses and sweeteners e.g. cyclamate, aspartame, isomalt, mannitol, sorbitol, xylitol, erythritol. The results show that more than 75% of the supplements for children available on the Polish market contain at least one sweetening agents

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or sweeteners [11]. Components such as sucrose or glucose syrup can even constitute more than 90% of the DS weight, as in the case of lollipops [12]. Consumption of these substances in excessive amounts may cause adverse health effects, such as tooth decay or obesity [13].

Most dietary supplements are consumed in the United States of America, while in Europe, the leaders are Italy, Russia, and Germany [14].

The decision to use dietary supplements should be made consciously and responsibly, preferably after consultation with a doctor or dietitian who will determine its justification after analyzing the nutritional status. The aim of this study was to analyze the influence of various socio-economic, health, nutritional, and physical activity factors on the use of dietary supplements in a selected group of children aged 3-10 years.

MATERIAL AND METHODS

Study design and data collection

The study was conducted among parents/guardians of 151 children attending kindergartens and primary schools in the Mazovia region. The data necessary for the analysis were obtained using a survey questionnaire, which was completed in the presence of the interviewer during parents' meetings in educational and upbringing facilities. The role of the interviewer was to explain precisely what we call DS (according to the applicable law) and to explain how to complete the survey and provide answers to questions from parents.

The questionnaire consisted of three parts. The first part contained questions on children's metrics and family socioeconomic data i.e. place of living and economic status; parents' education; child's age and gender; and factors related to the child's health and physical activity.

The second part of the questionnaire contained questions about the children's eating habits i.e. the number and regularity of meal consumption, the deliberate exclusion and inclusion of products from/in the diet, and the consumption of fortified products.

The third part of the questionnaire contained questions on the intake of dietary supplements during the year before the study i.e. name of preparation, form (tablets, capsules, drops, etc.), frequency and duration of consumption, recommendations, and motives for use. They were also asked about the preparations they were currently taking, and if they were taking more than one, they were asked to indicate whether and which were used concurrently.

Based on the children's weight and height declared by the parents, the Body Mass Index (BMI) was calculated. The BMI indice was categorized in accordance with the cut-off values for children and adolescents depending on age and gender based on percentile charts, assuming values $\leq$ 10th percentile as underweight, between the 10th and 90th percentile as normal weight, and $\geq$ 90th percentile as overweight or obesity [15, 16].

Statistical analysis

Statistical analysis of the results was performed using Statistica 13.0 PL by StatSoft. The results were presented separately for the children in kindergarten (3-6 years) and the children in elementary schools (7-10 years). The association between the use of supplements and quantitative characteristics (age, BMI) was assessed using the Student t-test for independent samples, and for qualitative characteristics, the *Chi*-square test using, where necessary, the Yates correction or Fisher's exact test. In the case of a significant association between factors with more than one category and the use of dietary supplements, a post hoc analysis was performed. The level of statistical significance was set at $p < 0.05$.

RESULTS

The study included 151 children, 46.4% boys and 53.6% girls, with an average age of 6.8 ± 2.5 years.

The vast majority of children lived in cities (83.4%) in families with declared a good financial situation (58.9%). Their parents usually had higher education (65.6% of mothers, 51.7% of fathers) (Table 1). The children in the study were characterized by good (57%) or very good (36.4%) health, without chronic diseases (86.8%) (Table 2).

Among the analyzed socio-economic factors, a statistically significant relationship was found only between the mother's education and the use of DS. It was shown that women with university education administered this type of preparation to children significantly more often than those with secondary and primary education (60.6% vs. 42.3%, respectively, $p = 0.0319$) (Table 1). It was also found that statistically more children with normal body weight received dietary supplements compared to children with overweight and obesity (58.6% vs. 27.3%, respectively, $p = 0.0396$) (Table 2).

Nearly half of the children (49%) surveyed consumed the recommended number of meals daily (i.e. ≥ 5) and almost all children regularly ate their main meals. A small percentage of parents intentionally included specific foods in their children's diet (12.6%), mainly vegetables, fruit, and fish. On the other hand, 29.1% of parents deliberately excluded products such as sweets, fast food, fizzy drinks, and milk and milk products because of their children's allergies (Table 3). Of the eating habits, only consuming fortified foods

Table 1. Characteristics of the group of examined children about dietary supplement use

Parameters		Total[1]		Use of dietary supplements[2]				p-value
				Yes		No		
		n	%	n	%	n	%	
Total		151	100	82	54.3	69	45.7	-
Gender	male	70	46.4	38	54.3	32	45.7	0.9965
	female	81	53.6	44	54.3	37	45.7	
Age (years)	3-6	66	43.7	40	60.6	26	39.4	0.1708
	7-10	85	56.3	42	49.4	43	50.6	
Residential area	urban	126	83.4	67	53.2	59	46.8	0.5314
	rural	25	16.6	15	60.0	10	40.0	
Mother's education level	primary/high school	52	34.4	22	42.3	30	57.7	0.0319
	university	99	65.6	60	60.6	39	39.4	
Father's education level	primary/high school	73	48.3	35	47.9	38	52.1	0.1291
	university	78	51.7	47	60.3	31	39.7	
Socio-economic status	very good	30	19.9	15	50.0	15	50.0	0.4277
	good	89	58.9	51	57.3	38	42.7	
	average	29	19.2	14	48.3	15	51.7	
	poor	3	2.0	2	66.7	1	33.3	

[1] – % calculated for all respondents; [2] – % calculated for a given category; p-value was determined using *Chi*-square test, statistical significance at the level $p < 0.05$

Table 2. The use of dietary supplements in the studied group of children and selected factors related to health and physical activity

Parameters		Total[1]		Use of dietary supplements[2]				p-value
		n	%	Yes		No		
				n	%	n	%	
Health status	very good	55	36.4	25	45.5	30	54.5	0.1968
	good	86	57.0	53	61.6	33	38.4	
	average	8	5.3	4	50.0	4	50.0	
	poor	2	1.3	-	-	2	100.0	
Current chronic diseases	yes	20	13.2	13	65.0	7	35.0	0.3026
	no	131	86.8	69	52.7	62	47.4	
Physical activity (rated by parents) n = 85[3]	high	39	45.9	22	56.4	17	43.6	0.5042
	medium	42	49.4	19	45.2	23	54.8	
	low	4	4.7	1	25.0	3	75.0	
Extracurricular sports activities n = 85[3]	yes	56	65.9	31	55.4	25	44.6	0.1276
	no	29	34.1	11	37.9	18	62.1	
Body Mass Index n = 85[3]	underweight [a, b]	5	5.9	2	40.0	3	60.0	0.0396
	normal weight [a]	58	68.2	34	58.6	24	41.4	
	overweight/obesity [b]	22	25.9	6	27.3	16	72.7	

[1] – % calculated for all respondents; [2] – % calculated for a given category; [3] – factors assessed only in the group of children of early school age (7-10 years old); [a, b] – different letters indicate statistically significant differences between groups at the level of $p < 0.05$ determined by the *Chi*-square test

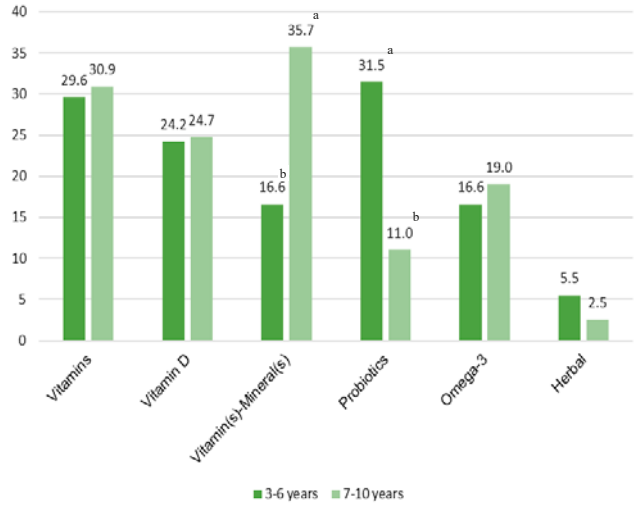
was significantly associated with dietary supplements. Concomitant use of supplements with fortified products was observed in 71.4% of subjects and was significantly higher compared to children not consuming fortified foods.

Dietary supplements were taken by 54.3% of the children studied during the year before the study. It was shown that younger children (3-6 years old) used probiotics significantly more often than older children (7-10 years old) (31.5% vs. 11.0%). On the other hand,

Table 3. The use of dietary supplements in the studied group of children and factors related to selected eating habits

Parameters		Total[1]		Use of dietary supplements[2]				p-value
		n	%	Yes		No		
				n	%	n	%	
Number of meals/day	≤ 3	12	7.9	4	33.3	8	66.7	0.2775
	4	65	43.1	35	53.8	30	46.2	
	≥ 5	74	49.0	43	58.1	31	41.9	
Consumption of I breakfasts	yes	144	95.3	81	56.3	63	43.7	0.1742
	no	1	0.7	-	-	1	100.0	
	differently	6	4.0	1	16.7	5	83.3	
Consumption of II breakfasts	yes	104	68.9	56	53.8	48	46.2	0.4523
	no	10	6.6	6	60.0	4	40.0	
	differently	37	24.5	20	54.1	17	45.9	
Consumption of dinner	yes	149	98.6	81	54.4	68	45.6	0.3624
	no	1	0.7	1	100.0	-	-	
	differently	1	0.7	-	-	1	100.0	
Consumption of afternoon snacks	yes	88	58.3	55	62.5	33	37.5	0.0706
	no	15	9.9	6	40.0	9	60.0	
	differently	48	31.8	21	43.7	27	56.3	
Consumption of supper	yes	145	96.0	79	54.5	66	45.5	0.2156
	no	4	2.7	3	75.0	1	25.0	
	differently	2	1.3	-	-	2	100.0	
Excluding some food products	yes	44	29.1	27	61.4	17	38.6	0.2642
	no	107	70.9	55	51.4	52	48.6	
Including some food products	yes	19	12.6	12	63.2	7	36.8	0.2678
	no	132	87.4	70	53.0	62	47.0	
Fortified food consumption	yes	98	64.9	70	71.4	28	28.6	< 0.0001
	no	53	35.1	12	22.6	41	77.4	

[1] – % calculated for all respondents; [2] – % calculated for a given category; p-value was determined using *Chi*-square test, statistical significance at the level $p < 0.05$



percentages add to > 100 as participants were able to select > 1 dietary supplement; a, b – different letters indicate statistically significant differences between children`s age groups at the level of $p < 0.05$ determined by the *Chi*-square test

Figure 1. Percentages of different types of dietary supplements among children using dietary supplements

older children took vitamin and mineral supplements significantly more often than younger children (35.7% vs. 16.6%). Vitamin preparations were in second place in terms of popularity (about 30%), and omega-3 acids were in third place (16.6-19%), regardless of the age of the study participants. In both the younger group of children (3-6 years old) and the older group (7-10 years old), approximately 24% consumed vitamin D supplements. Herbal preparations were among the least frequently used supplements (Figure 1).

Most often, dietary supplements were used for a relatively short period, up to 1 month (44%). At the same time, a large group of children (40%) took them for a more extended period (over six months). The vast majority of children (66%) took one preparation daily. Two preparations were used by about 28% of children, and three – almost 6%.

Most often, parents decided to supplement themselves (62%), only 35% on a doctor's recommendation or after consultation with a pharmacist (3%). Among the main motives for

Table 4. Reasons for using dietary supplements or not using them by children

Parameters	Children 3-6 years	Children 7-10 years	p-value
	%[1]	%[1]	
Reasons for using DS[2]			
Improve overall health	82.5	73.8	NS
Diet poor in nutrients	25.0	59.4	0.0008
Increase immunity	17.5	21.4	NS
Necessary when medicines are used	23.1	2.4	0.0047
Reason for avoiding DS[2]			
No effect on health improvement	18.5	27.3	NS
No need for use due to proper nutrition	88.9	56.8	0.0046
It can be harmful	7.4	18.2	NS
Too high price	3.7	9.1	NS

[1] – % calculated for the number of children using SD in a given age group; [2] – percentages add to > 100 as participants were able to select > 1 reason for using; p-value was determined using *Chi*-square test, statistical significance at the level $p < 0.05$; NS – non-significant; DS – dietary supplements

using dietary supplements in children, parents mentioned improvement in health after the use of these preparations (in the group of 3-6-year-olds – 82.5%, in the group of 7-10-year-olds – 73.8%) and the belief that their child's diet was deficient in nutrients (in the group of 3-6-year-olds – 25.0%, in the group of 7-10-year-olds – 59.4%). Another reason for supplementation was the desire to increase children's immunity (in the group of 3-6-year-olds – 17.5%, in the group of 7-10-year-olds – 21.4%). It was found that supplementation in younger children was significantly more often due to the need for medicines, compared to older children (23.1% vs. 2.4% respectively, $p = 0.0047$). Parents' reasons for deciding not to use dietary supplementation in their children were also analyzed. The most frequently cited reasons were that there was no legitimate need for their use and that these preparations did not benefit health. Another answer, which was also often given, was that supplements may harm health and that they are too expensive (Table 4).

DISCUSSION

The use of dietary supplements depends on various factors, which may differ depending on the population group and country. Many studies show that the frequency of DS use may depend on the price and availability of the product in the market, the season, or the consumer's lifestyle. Dietary supplements are consumed more often by people characterized by greater physical activity, a healthy lifestyle, and those who avoid addictions. It has been shown that in the American population, slim women with a higher level of education and socio-economic status use supplements more often than other population groups. Adults who consume DS are also more likely to give them to their children. Unfortunately, there are few studies on the problems and effectiveness of using dietary supplements in children [7].

The results of this study indicate that the use of dietary supplements in children aged 3-10 was relatively frequent; 54.3% of children received at least one preparation during the year preceding the study. A similar percentage of children (54.9%) using dietary supplements was found in a study conducted in Wrocław (Poland) among 532 children aged 3 to 12 years [17]. Also, a national survey of children aged 1-10 years in the USA estimated that 52% of children used dietary supplements regularly, while about 33% took them occasionally [8]. However, studies conducted in Turkey in a group of healthy children aged 2-18 years showed that 32.5% of the children were using DS on the day of the study, and 11.6% had used it before [18]. Studies conducted in Korea in 2015-2017 showed a decreasing trend in the use of supplements with the age of children. About 39.2% of 1-3 year olds received dietary supplements, while only 12.3% of youth aged 10-18 received them [19]. In the Australian population, 20.1% of adolescents (aged 10-17) and 23.5% of children (< 9 years) used at least one dietary supplement in the last two weeks [20]. Studies conducted in various countries have reported that the use of dietary supplements in children is 7.6–32% [21-23]. Unfortunately, despite recommendations for vitamin D supplementation, in this study, only around 24% of each age group were taking the vitamin (in the group of 3-6-year-olds – 24.2%, and in the group of 7-10-year-olds – 24.7%). Similar results were obtained in the study by Koç et al. [18]. Significantly lower vitamin D supplementation was found among US children, where around 1.6% used it [23].

In this study, among the analyzed socioeconomic factors, a statistically significant effect was found

only for the mother's education level. Women with university education were significantly more likely to give their children this type of preparation than those with secondary and primary education (60.6% vs. 42.3%, respectively, p = 0.0319). A similar relationship was also found in Turkey and China in school-age children [18, 24]. In addition, such a relationship was related to the fact that the parents were healthcare workers with better economic status and were themselves taking DS [18]. In contrast, a cross-sectional study among students aged 7 to 18 in Iran showed that children with a higher level of father's education used fewer supplements. However, living area, family size, and paternal occupation indicated no significant association [25]. Slightly different trends were found in the US study, where not only the level of education of parents but also higher financial status and higher household food security levels and private health insurance coverage influenced the administration of dietary supplements to children. In addition, there was a significant trend toward lower DS use with increasing age in this study [23].

In our study also found that school-aged children with normal body weight were statistically more likely to use supplements than children with overweight and obesity (58.6% vs. 27.3% respectively, p = 0.0396). Results from a USA study also showed that weight status in children was inversely associated with DS use [23]. A similar relationship was also found in Korean children, in whom DS intake was associated with lower BMI and lower birth weight [19]. A similar trend was also observed among children in Turkey [18] and adolescents in Germany [22].

Numerous studies on the determinants of dietary supplementation indicate that users of dietary supplements are more likely to have a more proper diet [17, 19]. Health-promoting behaviors also include consuming fortified products, which can be a significant source of nutrients. This study showed that among people using fortified products, 71.4% were also receiving vitamin/mineral preparations. This creates a risk of exceeding the upper limit of intake (UL) of a nutrient, which is particularly dangerous for children. It was proven that the excessive supply of e.g., iron, zinc, vitamin A or vitamin D [26-29] – nutrients, which play a crucial role in the functioning of the immune system, may have a synergistic or antagonistic influence on other ingredients found in food.

Improperly using dietary supplements, e.g., taking several preparations simultaneously, not following the recommended doses, or supplementing an adequately composed diet, may lead to health consequences such as hypervitaminosis. The most frequently reported side effects of DS include diarrhea, constipation, nausea/vomiting, and abdominal pain [21]. Our results confirm, the duration of use of the dietary supplement was often short and amounted to 1 month (44%). While at the same time, a large group of children (40%) took DS longer, even over six months. In turn, in the study conducted by Sicinska et al. [10] among Polish public school students, it was found that DS was most often used for 1-3 months.

In our research we have shown, most children (66%) took one preparation daily, and about 34% took more than one. Similar results were obtained among German adolescents, where most users had consumed only one kind of dietary supplement (72.7%), and about a quarter (27.3%) had consumed more than one [22]. In contrast, a study involving Turkish children showed a higher percentage of people (49.9%) using more than one DS at the same time [18].

The most frequently used dietary supplements among younger children were probiotics; among older children, they were vitamin-mineral preparations, which is consistent with other literature [17, 19, 21]. The use of probiotics is undoubtedly related to doctors' recommendations in regards to the protective measures of such products during antibiotic therapy and also on the increasing of nutrition absorption capacities in healthy children [30, 31].

In this study, the parents of children indicated the improvement of the general health of children and a diet poor in nutrients, as well as increased immunity as the main reasons for using DS; at the same time, parents of preschool children significantly more often declared the supply of supplements due to the necessity of taking medications. Similarly, in the Japanese [21] and American populations [23], the main motivation for using DS in children and adolescents was improving general health and preventing nutrient deficiencies.

CONCLUSIONS

Based on the study, it can be concluded that using dietary supplements in children aged 3-10 years was common, and in most cases, the decision was made alone. The higher mother's education, children's BMI, and consumption of fortified foods were predictors of DS use. The decision to use dietary supplements should be made consciously and responsibly, preferably after consultation with a specialist. Supplementation should be selected individually and rationally, and a properly balanced diet should be the basis. The administration of food supplements to children can only be justified in the case of vitamin D. It, therefore, seems appropriate to increase parents' knowledge of the use and how to choose the best possible supplement, as dietary supplementation should always be tailored to individual needs. Understanding the determinants affecting the use of dietary supplements in children may determine the risk of their incorrect use and allow

the planning of appropriate public health education; therefore, further research is warranted.

Conflict of interest

Author declares no conflicts of interest.

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ORIGINAL ARTICLE

DIETARY HABITS OF EARLY SCHOOL-AGED CHILDREN AND NUTRITIONAL KNOWLEDGE OF THEIR PARENTS

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ABSTRACT

Background. The early school period is essential in shaping dietary habits. This process is largely dependent on the nutritional knowledge of parents and caregivers.

Objective. To assess the impact of parents' nutritional knowledge on the frequency of consumption of selected groups of food products by their children at early-school aged.

Material and Methods. The survey, in the form of an online survey, was conducted among parents of children from grades 1-3. The study included 179 children aged 6-11 years (mean 8.1), 54.5% of whom were girls. Questions about children's eating habits included the frequency of consumption of specific product groups (fruits, vegetables, dairy products, whole grain cereal products, fish, meat, cold cuts, legumes, nuts and seeds, eggs, sweets). Nutritional knowledge was determined on the basis of parents' self-assessment. Statistical analysis included a heat map and Pearson correlation.

Results. A high level of nutritional knowledge of parents was associated with a high correlation in the consumption of fruits and vegetables (0.64), and in the case of vegetable consumption with a high correlation with the consumption of whole grains and legumes. Negative correlations were found between meat consumption and consumption of vegetables, whole grains and legumes. In the nutrition model of children of people declaring a lack of nutritional knowledge, a strong positive correlation was also found between the consumption of fruit and vegetables (0.72), vegetables and meat (0.75), as well as nuts and milk (0.75). The consumption of sweets was strongly correlated with the consumption of fish, legumes and cold cuts, and negatively correlated with the consumption of whole grains, meat and nuts. The heat map shows a clearly higher consumption of sweets and cold cuts among children of people declaring a lack of nutritional knowledge.

Conclusions. Research confirms that parents' high nutritional knowledge is associated healthier food choices for their children.

Keywords: *dietary habits, children, nutritional knowledge, parents, heat map*

INTRODUCTION

Developing proper eating habits in early childhood can be key to maintaining good health in adulthood. Children learn most effectively by observing their parents' dietary habits, especially when it is accompanied by emotions [1]. That is why parents' health-promoting dietary choices are so important. Achieving good results is associated with long-term nutritional education, not only of the family, but also of mass catering entities, such as kindergartens and schools, where children spend a large part of the day [2, 3]. In recent years, there has been a growing trend of implementing school projects that promote a healthy lifestyle, including those that shape proper eating habits or physical activity [4].

The basis for the correct composition of the children's diet, illustrated in the Pyramid of healthy nutrition and lifestyle for children and adolescents, should be colorful vegetables and fruits. The pyramid, along with the accompanying rules, emphasizes the important role of fish, legumes, and nuts. Simultaneously, attention is drawn to the need to eliminate added sugar, which contributes to the development of dental caries and obesity [5]. In 2015, as many as 76% of children aged 12 in Poland were diagnosed with tooth decay, and this percentage increased with age [6]. This problem also affects other countries, where 60-90% of school-age children suffer from dental caries [7]. According to WHO recommendations, sugar consumption should not exceed 10% of energy. However, it seems that in order to prevent caries, sugar consumption should not exceed 2-3% of energy [8].

An improperly balanced diet is also one of the main risk factors for the development of obesity. Excess body weight is currently one of the major public health problems worldwide [9]. The problem of obesity and overweight affects about 30% of children

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aged 7-9 in Poland and the trend is growing [10]. Over the last 30 years, the percentage of children affected by this problem has increased by about 5 percentage points [11]. Unfortunately, the prevalence of excess body weight among preschoolers and children starting school in Poland is higher than the European average [12]. Besides lifestyle, including diet, there are many other risk factors for obesity. Breastfeeding, especially the period of exclusive breastfeeding, the parents' body weight, the health status of family members and the child's birth weight are negatively correlated with excess body weight [4].

Treatment of childhood obesity should be based on dietary modification, increased physical activity and psychological support. However, any interventions aimed at lifestyle changes should involve the whole family to be effective. Therefore, educating parents in this area is crucial [12].

Parents' lifestyle, including eating behaviors and nutritional knowledge, are correlated with the quality of their children's diet. People with higher knowledge tend to make healthier food choices, but they are also more aware of the impact of diet on the long-term health of children [13, 14]. According to a nationwide study of eating habits, over 80% of parents of children aged 3-9 claim to have a high level of nutritional knowledge and that their children have good or very good diet [15]. Unfortunately, research shows that practical nutritional knowledge is still insufficient [16]. Moreover, the main source of nutritional knowledge for Polish parents is the Internet or family, and much less often specialists such as dieticians, doctors or nurses [17].

Therefore, the aim of this study was to estimate the frequency of consumption of specific product groups and to assess the nutritional knowledge of parents based on self-assessment. In addition, the aim was to investigate the correlation between parents' knowledge and the consumption of the above-mentioned products by their children.

MATERIAL AND METHODS

The study was conducted in 2024 among parents or legal guardians of children in grades 1-3 of primary school. The online survey was prepared using Google Forms software and then shared on social media. Before completing the questionnaire, each respondent read the cover letter explaining the purpose of the study and assuring the anonymity and voluntary participation. Questions about children's eating habits included the frequency of habitual intake of specific product groups: fruits (fresh, frozen), vegetables (fresh, frozen, except potatoes), dairy products, whole grain cereal products (bread, groats, rice and pasta), fish (including seafood), meat (excluding cold cuts), cold cuts (including sausages), legumes, nuts and seeds, eggs, sweets (including dairy products sweetened with sugar). The question was "how often one serving of the product is consumed". The responses were as follows: "several times a day", "once a day", "several times a week", "several times a month", "less than once a month", "does not consume" for all questions except "fish", for this group the answers were: "more than 2 times a week", "1-2 times a week", "less than 1 time a week", "does not consume". Parents' nutritional knowledge was determined based on their self-assessment, i.e. the answers to the question "How do you assess your knowledge on child nutrition guidelines?". Before distributing the survey, the pilot study was conducted among 5 people.

Statistical analysis, divided by gender, was performed using the Pearson *chi*-square test (for qualitative variables) and the Mann-Whitney U test (for quantitative variables), with a significance level of $p \leq 0.05$. For qualitative characteristics, the number of persons and percentage are given, while for quantitative variables the mean, standard deviation (SD) and range (minimum – maximum) were provided. The normality of the distribution was tested using the Shapiro-Wilk test. Data were analyzed using the Statistica software version 13.3PL.

In order to observe the relationship between the declared nutritional knowledge of parents or caregivers and the tendencies in the consumption of given groups of food products, the Tau Kendall correlation analysis was used. In addition, a scaled heat map created with the R studio program was used to show hidden relationships between the frequency of consumption of the analyzed food groups and the declared nutritional knowledge of parents and/or caregivers.

RESULTS

The study was conducted among 178 children aged 6-11 (average 8.1, SD 1.1), of whom 55% were girls. Girls were characterized by a slightly lower BMI (16.9 kg/m^2 vs. 17.9 kg/m^2; $p = 0.058$) and a significantly better financial situation of the family (for "good status", respectively 74.2% vs. 53.1%; $p = 0.009$), than boys. More than 70% of parents rated their child's physical activity as at least high. About 16% of children had a food intolerance or allergy (Table 1).

Table 2 presents the characteristics of the intake of the analyzed food groups by children and the self-assessment of nutritional knowledge of parents. Girls, compared to boys, statistically significantly more often intake fruits (minimum one a day 83.5% girls vs. 59.2% boys; $p = 0.007$) and vegetables (minimum one a day 74.3% girls vs. 55.6% boys; $p = 0.034$), while boys – meat (minimum one a day 49.4% boys vs. 23.7% girls; $p = 0.005$) and sweets (minimum one a day 39.3% boys

Table 1. General characteristics of the studied children

Factor	Total N = 178 (100%)	Girls N = 97 (54.5%)	Boys N = 81 (45.5%)	p
Child's age [years]				
Average (SD)	8.1 (1.1)	8.2 (1.1)	8.0 (1.1)	0.257[1]
Range	6-11	6-11	6-10	
Residential area				
Village	62 (34.9)	36 (37.1)	26 (32.9)	0.423[2]
City ≤ 100,000 inh.	59 (33.1)	34 (35.1)	25 (30.1)	
City > 100,000 inh.	57 (32.0)	27 (27.8)	30 (37.0)	
Self-rated economic status of family				
Good	115 (64.6)	72 (74.2)	43 (53.1)	0.009[2]
Average	62 (34.8)	25 (25.8)	37 (45.7)	
Poor	1 (0.6)	0	1 (1.2)	
Child BMI [kg/m^2]				
Average (SD)	17.3 (2.8)	16.9 (2.5)	17.9 (3.1)	0.058[1]
Range	12.2-24.5	12.2-24.4	13.1-24.5	
Child's physical activity				
Very high	45 (25.3)	20 (20.6)	25 (30.9)	0.256[2]
High	81 (45.5)	45 (46.4)	36 (44.4)	
Average	45 (25.3)	29 (29.9)	16 (19.8)	
Low	7 (3.9)	3 (3.1)	4 (4.9)	
Food allergy/intolerance				
No	149 (83.7)	81 (83.5)	68 (83.9)	0.936[2]
Yes	26 (16.3)	16 (16.5)	13 (16.1)	

[1] – Mann-Whitney U test; [2] – Pearson's *chi*-squared test, p ≤ 0.05

Table 2. Intake of food groups by children and nutritional knowledge of parents

Factor	Total N = 178 (100%)	Girls N = 97 (54.5%)	Boys N = 81 (45.5%)	p[1]
Fruits				
Several times a day	60 (33.7)	39 (40.2)	21 (25.9)	0.007
Once a day	69 (38.8)	42 (43.3)	27 (33.3)	
Several times a week	38 (21.4)	14 (14.4)	24 (29.6)	
Several times a month	5 (2.8)	1 (1.0)	4 (4.9)	
Less than once a month	2 (1.1)	1 (1.0)	1 (1.2)	
Does not consume	4 (2.2)	0	4 (4.9)	
Vegetables				
Several times a day	70 (39.3)	47 (48.5)	23 (28.4)	0.034
Once a day	47 (26.4)	25 (25.8)	22 (27.2)	
Several times a week	38 (21.3)	16 (16.5)	22 (27.2)	
Several times a month	16 (9.0)	8 (8.2)	8 (9.9)	
Less than once a month	4 (2.3)	1 (1.0)	3 (3.7)	
Does not consume	3 (1.7)	0	3 (3.7)	
Dairy products				
Several times a day	61 (34.3)	28 (28.8)	33 (40.7)	0.175
Once a day	74 (41.6)	47 (48.5)	27 (33.3)	
Several times a week	35 (19.6)	17 (17.5)	18 (22.2)	
Several times a month	2 (1.1)	2 (2.1)	0	
Less than once a month	1 (0.6)	1 (1.0)	0	
Does not consume	5 (2.8)	2 (2.1)	3 (3.7)	
Whole grain cereal products				
Several times a day	35 (19.7)	25 (25.8)	10 (12.4)	0.207
Once a day	31 (17.4)	18 (18.6)	13 (16.1)	
Several times a week	58 (32.6)	26 (26.8)	32 (39.5)	
Several times a month	33 (18.5)	18 (18.6)	15 (18.5)	
Less than once a month	12 (6.7)	5 (5.1)	7 (8.6)	
Does not consume	9 (5.1)	5 (5.1)	4 (4.9)	

Factor	Total N = 178 (100%)	Girls N = 97 (54.5%)	Boys N = 81 (45.5%)	p[1]
Fish				
More than 2 times a week	7 (3.9)	4 (4.1)	3 (3.7)	
1-2 times a week	48 (27.0)	27 (27.9)	21 (25.9)	0.958
Less than 1 time a week	95 (53.4)	52 (53.6)	43 (53.1)	
Does not consume	28 (15.7)	14 (14.4)	14 (17.3)	
Legume seeds				
Several times a day	2 (1.1)	1 (1.0)	1 (1.2)	
Once a day	1 (0.6)	1 (1.0)	0	
Several times a week	37 (20.8)	25 (25.8)	12 (14.8)	0.302
Several times a month	56 (31.5)	33 (34.0)	23 (28.4)	
Less than once a month	11 (6.2)	14 (14.5)	15 (18.5)	
Does not consume	53 (29.8)	23 (23.7)	30 (37.1)	
Eggs				
Several times a day	7 (3.9)	2 (2.1)	5 (6.2)	
Once a day	17 (9.6)	10 (10.2)	7 (8.6)	
Several times a week	106 (59.6)	61 (62.9)	45 (55.6)	0.262
Several times a month	39 (21.9)	22 (22.7)	17 (21.0)	
Less than once a month	1 (0.6)	0	1 (1.2)	
Does not consume	8 (4.4)	2 (2.1)	6 (7.4)	
Meat				
Several times a day	16 (8.9)	4 (4.1)	12 (14.8)	
Once a day	47 (26.4)	19 (19.6)	28 (34.6)	
Several times a week	101 (56.7)	64 (66.0)	37 (45.7)	0.005
Several times a month	12 (6.7)	8 (8.2)	4 (4.9)	
Less than once a month	0	0	0	
Does not consume	2 (1.1)	2 (2.1)	0	
Cold cuts				
Several times a day	20 (11.2)	7 (7.2)	13 (16.0)	
Once a day	54 (30.3)	29 (29.9)	25 (30.9)	
Several times a week	66 (37.1)	35 (36.1)	31 (38.3)	0.288
Several times a month	25 (14.1)	17 (17.5)	8 (9.9)	
Less than once a month	4 (2.2)	3 (3.1)	1 (1.2)	
Does not consume	9 (5.1)	6 (6.2)	3 (3.7)	
Nuts and seeds				
Several times a day	7 (3.9)	5 (5.2)	2 (2.5)	
Once a day	20 (11.2)	10 (10.3)	10 (12.3)	
Several times a week	65 (36.5)	40 (41.2)	25 (30.9)	0.449
Several times a month	41 (23.1)	21 (21.7)	20 (24.7)	
Less than once a month	12 (6.7)	4 (4.1)	8 (9.9)	
Does not consume	33 (18.6)	17 (17.5)	16 (19.7)	
Sweets				
Several times a day	27 (15.2)	11 (11.3)	16 (19.7)	
Once a day	53 (29.8)	29 (29.9)	24 (29.6)	
Several times a week	72 (40.4)	39 (40.2)	33 (40.7)	0.036
Several times a month	22 (12.4)	18 (18.6)	4 (4.9)	
Less than once a month	1 (0.6)	0	1 (1.2)	
Does not consume	2 (1.1)	0	2 (2.5)	
Self-rated of parents' nutritional knowledge				
Very good	15 (8.4)	9 (9.3)	6 (7.4)	0.784
Good	83 (46.6)	42 (43.3)	41 (50.6)	
Average	72 (40.5)	41 (42.3)	31 (38.3)	
Lack	8 (4.5)	5 (5.1)	3 (3.7)	

[1] – Pearson's *chi*-squared test, $p \leq 0.05$

vs. 41.2% girls; p = 0.036). In the entire study group, there was a relatively high percentage of children who did not eat any legumes (almost 30%), nuts and seeds (almost 19%) or fish (almost 16%).

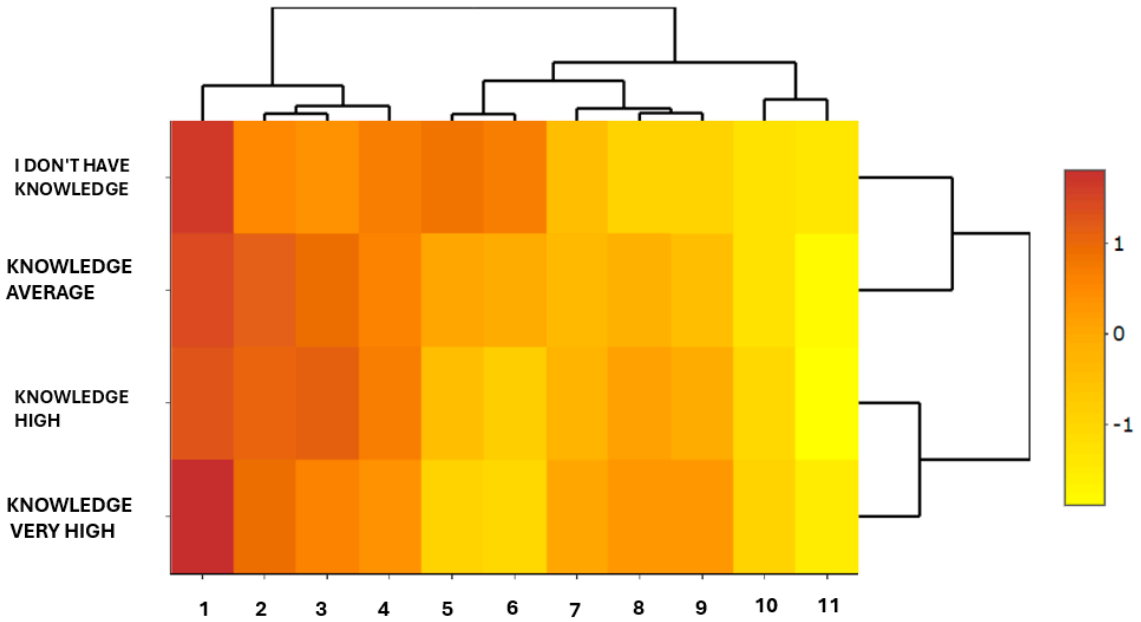
The correlation between the declared nutritional knowledge of parents and guardians of children (very high knowledge, high knowledge, medium knowledge, lack of nutritional knowledge) in preferences in the consumption of 10 groups of food products is presented in Table 3. In the case of children from families in which parents or caregivers declared a high level of nutritional knowledge, a high correlation was found between the consumption of fruit and vegetables (0.64), and a high correlation coefficient was noted between the consumption of vegetables and whole grains (0.61). The consumption of legumes was highly correlated with the consumption of fruit (0.59), vegetables (0.66) and whole grain products (0.59). On the other hand, meat consumption showed a high correlation with fruit consumption (0.58), and at the same time negatively correlated with the consumption of vegetables (-0.59), whole grains (-0.75), fish (-0.55) and legumes (-0.63). Correlations between the frequency of consumption of selected food product groups by children of parents or caregivers declaring a lack of nutritional knowledge reached a high level in the case of fruit and vegetable consumption (0.72), as well as between the consumption of eggs and vegetables and eggs and milk (0.72). The consumption of meat and fruit correlated at the level of 0.7 and meat and vegetables at the level of 0.75. For the consumption of cold cuts and fish, a negative correlation was recorded at the level of -0.55. An interesting phenomenon observed is the occurrence of a high positive correlation between the consumption of nuts and seeds and milk, whole grains, fish and eggs, respectively the correlation coefficients corresponded to the levels of 0.75, 0.72, 0.56 and 0.70. The consumption of sweets was negatively correlated with the consumption of whole grains (-0.73) and positively with the consumption of cold cuts (0.73) and legumes (1.00).

The use of statistical analysis based on a scaled heat map (Figure 1) allowed to show hidden relationships between the declared nutritional knowledge of parents and/or caregivers and groups of food products used in children's nutrition. The products whose intake is the most common in all surveyed families, regardless of the declared nutritional knowledge, come to the fore,

Table 3. Calculated Kendall's *tau* correlation coefficients between the declared nutritional knowledge of parents and/or caregivers in relation to the frequency of consumption of selected groups of food products by children

	Knowledge	Fruits	Vegetable	Milk	Whole grain cereal products	Fish	Legumes	Egg	Meat	Cold Cuts	Nuts and seeds
Vegetable	Lack	0.72									
	Average	0.46									
	Good	0.44									
	Very good	0.64									
Milk	Lack	0.12	0.33								
	Average	-0.02	0.07								
	Good	-0.03	0.13								
	Very good	0.18	0.24								
Whole grain cereal products	Lack	0.06	0.32	0.24							
	Average	0.19	0.34	-0.03							
	Good	0.19	0.24	0.09							
	Very good	0.53	0.61	0.27							
Fish	Lack	0.10	0.07	0.22	0.22						
	Average	0.10	0.20	-0.01	0.17						
	Good	0.17	0.1	-0.04	0.23						
	Very good	0.18	0.27	0.23	0.33						
Legumes	Lack	-0.08	0.22	-0.22	0.73	0.22					
	Average	0.21	0.52	0.15	0.47	0.19					
	Good	0.22	0.45	0.01	0.42	0.26					
	Very good	0.59	0.66	0.31	0.59	0.38					

	Knowledge	Fruits	Vegetable	Milk	Whole grain cereal products	Fish	Legumes	Egg	Meat	Cold Cuts	Nuts and seeds
Egg	Lack	0.52	0.72	0.72	0.34	0.18					
	Average	0.03	0.17	0.23	0.17	0.08	0.26				
	Good	0.36	0.34	0.12	0.21	0.09	0.29				
	Very good	0.01	-0.03	-0.08	0.14	0.37	0.04				
Meat	Lack	0.70	0.75	-0.45	0.21	0.31	0.49	-0.59			
	Average	-0.11	-0.01	0.13	-0.23	-0.08	0.00	0.11			
	Good	0.27	0.15	0.18	0.10	0.01	0.02	0.38			
	Very good	0.58	-0.59	-0.07	-0.75	-0.55	-0.63	-0.29			
Cold cuts	Lack	0.12	-0.32	0.32	-0.46	0.22	-0.73	0.06	-0.22		
	Average	-0.22	-0.10	0.01	-0.24	0.02	-0.16	0.06	0.38		
	Good	-0.03	-0.07	0.03	-0.04	-0.06	-0.07	0.16	0.21		
	Very good	-0.04	0.05	-0.17	0.47	-0.55	-0.17	-0.26	0.40		
Nuts and seeds	Lack	0.05	0.44	0.75	0.72	0.56	0.49	0.70	-0.07	-0.21	
	Average	0.33	0.33	-0.02	0.42	0.10	0.35	0.25	-0.09	-0.23	
	Good	0.29	0.14	0.10	0.38	0.12	0.23	0.30	0.26	-0.06	
	Very good	0.33	0.34	-0.03	0.40	-0.10	0.32	0.42	-0.38	0.09	
Sweets	Lack	0.08	-0.22	0.22	-0.73	0.56	1.00	-0.08	-0.49	0.73	-0.49
	Average	-0.20	-0.29	0.24	-0.40	-0.14	-0.25	0.02	0.20	0.32	-0.22
	Good	-0.03	-0.14	0.10	-0.24	-0.20	-0.34	-0.14	0.16	0.18	-0.18
	Very good	0.33	0.10	0.34	0.29	0.04	0.19	-0.24	-0.13	-0.24	0.04



X-axis description: **1** – Consumption of meat, **2** – Consumption of milk, **3** – Consumption of fruits, **4** – Consumption of eggs, **5** – Consumption of sweets, **6** – Consumption of cold cuts, **7** – Consumption of vegetables, **8** – Consumption of nuts and seeds, **9** – Consumption of whole grain cereal products, **10** – Consumption of legumes, **11** – Consumption of fish

Figure 1. Influence of the frequency of consumption of selected groups of food products used in children's nutrition to the suggested level of nutritional knowledge of parents and caregivers (heat map)

and this group includes the consumption of meat, milk, fruits and eggs. It is clear that the frequency of consumption of sweets and cold cuts is lower, and seeds and nuts and whole grain cereal products bread is higher in families where parents or caregivers indicated the level of their nutritional knowledge to be very high and high. The scaled heat map also indicates that the frequency of fish consumption is the lowest among the given groups of food products and does not depend on the declared knowledge of parents.

DISCUSSION

The relationship between children's diet at home and subsequent eating habits has been the subject of many scientific studies [18-24]. Our study confirmed irregularities in the children's diet. We found insufficient consumption of fish and legumes by the entire study group, regardless of the child's gender and the parent's self-assessment of nutritional knowledge. According to Silva [19], patterns of food consumption begin to form in the earliest moments of life and continue throughout childhood. Early experiences with the consumption of specific foods are critical for the acceptance and consolidation of later eating habits.

The correlational analysis of the our research showed the existence of relationships between the frequencies of consumption of individual groups of food products, and these associations depended on the declared nutritional knowledge of parents and caregivers. Particularly noticeable differences occurred in the case of the frequency of fruits and vegetables consumption by children of parents and caregivers declaring a high level of their nutritional knowledge. In this case, a high positive correlation (0.72) was observed, what was not reflected in the other study groups. Simultaneously, it should be noted that there was a high negative correlation for the consumption of meat and whole grain cereal products. Which carries the information that with frequent meat consumption, the frequency of consumption of whole grain cereal products by children decreases and vice versa. Leal et al. [20] in their study among 7- and 10-year-olds found that the consumption of fruit and vegetables was too low, but this trend concerned families with low socioeconomic status and low level of parental education. Similar relationships related to parents' food choices for their children, depending on the level of knowledge, have been shown in their research by Ma L et al. [21]. Olfert et al. [22] noted in their research that special care should be given to the relationships that are formed between parents and their children on the basis of joint grocery shopping and meal preparation. On the other hand, Riasatian et al. [23] postulated that eating habits should be shaped as early as preschool children. And one of the important elements would be to include properly prepared educational games with elements of nutritional knowledge in the process of their formation. According to Fazrin et al. [24], there is a large influence between the role of parents in preparing a balanced menu and the nutritional status of children. In the literature on the subject, there are no unambiguous studies linking the frequency of consumption of food products by children depending on the declared nutritional knowledge of parents or caregivers. In the research of Vlieger et al. [25], an attempt was made to demonstrate the relationship between the impact of nutritional education in primary school on the nutritional attitudes of parents and their children. The examined children correctly sorted fruit and vegetables in terms of health, while uncertainties appeared in the case of cold cuts and muesli bars. The parents of the children also tried to actively participate in the nutritional education of their children, but nevertheless suggested that they felt insecure about their own level of knowledge about children's nutrition. It is the results of our own research that indicate how important in the nutritional education of children is the nutritional awareness of parents. In the case of parents indicating a lack of nutritional knowledge and its average level, irregularities in the frequency of consumption by their children of food products important for maintaining health can also be noticed. Correlational analysis showed the existence of a high positive correlation between the frequency of consumption of sweets and wholegrain cereal products (0.73), as well as sweets and legumes (a correlation coefficient of 1.00), as well as sweets and cold cuts and sweets and wholegrain cereal products (both 0.73). Such high correlations were not recorded in the case of the frequency of consumption of food product groups by children of parents declaring an average, good and very good level of their nutritional knowledge. Such correlation indicators indicate that the frequency of consumption of sweets is at the level of consumption of legumes, whole grain cereal products and cold cuts. Such a relationship was not observed in the case of children of parents declaring a high and medium level of their nutritional knowledge. The problem of the frequency of fish consumption in children, parents or guardians has been noticed, regardless of the declared level of their nutritional knowledge. The calculated correlation coefficients assumed weak or low levels. Problems with the frequency of fish consumption by early school children have also been noted in their studies by Menor-Rodriguez et al. [26]. Undoubtedly, nutritional education started as early as possible brings health benefits at a later age, i.a. lower body mass index (BMI) and reducing the risk of developing type 2 diabetes [25, 27-29]. Mahmood et al. [30] in a meta-analysis showed that appropriate parenting practices aimed at encouraging the consumption of healthy food

products, but without excessive pressure to implement them, are particularly beneficial. Czarniecka-Skubina et al. [31] showed that the process of health and nutritional education of children cannot be conducted separately from the health education of their parents. Active forms of nutritional education in the form of workshops related to theoretical issues are particularly desirable. Even one-off educational campaigns bring benefits related to changes in the eating and health habits of early primary school students towards increasing the consumption of fruit and vegetables or whole grain products [32].

However, in the subject matter of the subject, one can also come across a slightly different view of the role of parents, and in particular mothers, on shaping the child's eating habits. Namely, Kadir [33] in his work shows that there is no relationship between knowledge about parenting and the nutritional status of a preschool child. But he did notice the existence of a relationship between cultural parenting and the state of the child's nutrition. Such a way of looking at it marks the area of greater influence of culture than nutritional knowledge. Such cases can occur in particular in people with a low level of developed nutritional awareness. The topic of the impact of awareness on the food choices of parents and children attending primary school was addressed in Nahid's research [34]. Taking into account many factors influencing conscious food choices, he determined that without the support of an appropriate education system, the introduction of the principles of healthy eating by parents by parents is not very effective. The use of the heat map by us allowed for a deeper look into the dimension of the research space related to the results of own research on the parent-child relationship at the level of frequency of consumption of selected food groups and the suggested nutritional knowledge of parents. The area of differences in the frequency of consumption of selected groups of food products by children, depending on the declared nutritional knowledge has been clearly marked. Children of parents and caregivers declaring a very high and high level of nutritional knowledge in relation to children of parents and caregivers declaring no nutritional knowledge or its average level consumed sweets and cold cuts less often. And more often their menu included seeds and nuts as well as whole grain cereal products. The frequency of consumption of individual groups of food products by children is conditioned by the formation of eating habits, which should be shaped from an early age [30, 35-38].

CONCLUSIONS

1. Girls were more likely to eat fruit and vegetables, while boys were more likely to eat meat, cold cuts and sweets.
2. Stronger correlations in the frequency of consumption of individual groups of food products by children were observed in the case of parents or guardians declaring the level of their nutritional knowledge as high.
3. The gender of the child was an important factor in the differences, the frequency of consumption of vegetables, fruits, meat and sweets.
4. The frequency of consumption of individual groups of food products is correlated with the declared nutritional knowledge of parents.
5. Children of parents declaring their nutritional knowledge as very high were less likely than children of parents declaring a lower level of nutritional knowledge to eat sweets and cold cuts, and more often seeds and nuts, and whole grain cereal products.
6. To sum up your research, it should be emphasized that an important element in shaping children's attitudes and eating habits is the nutritional awareness and knowledge of parents. whose task is to transfer and consolidate their correctness in their charges. However, for more complete modelling, prudent educational and practical actions are needed among children, parents and educational institutions.

Conflict of interest

The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

EXPOSURE TO NITRITES FROM MEAT PRODUCTS AS FOOD ADDITIVES AMONG ADOLESCENTS IN POLAND

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ABSTRACT

Background. Nitrites should be limited in the diet because their potential carcinogenic effects. However, the addition of nitrites is essential to maintain the microbiological safety of meat products, mainly to protect them from bacteria *Clostridium botulinum* and to preserve the pink colour of meat products and to give them desirable organoleptic properties. Acceptable Daily Intake (ADI) for nitrite (expressed as nitrite ion) established by EFSA is 0.07 mg per kilogram of body weight per day (mg kg^{-1} day^{-1}), equivalent to 0.1 mg kg^{-1} day^{-1} of sodium nitrite.

Objective. The aim of this study was the assessment of sodium nitrite intake in meat products and exposure to this compound in Polish adolescents.

Materials and Methods. The analysis of sodium nitrite intake with selected meat products by young Poles was based on consumption data of these products by adolescents aged 11-17 in 2019-2020 and analytical data on the actual content of sodium nitrite in meat products provided by laboratories of sanitary and epidemiological stations in 2017 and 2018 (4 voivodships).

Results. The intake of sodium nitrite by adolescents aged 11-17 years in total, both the mean (0.063 mg kg^{-1} day^{-1}) and the median (0.050 mg kg^{-1} day^{-1}) did not exceed ADI. On the other hand, the intake of sodium nitrite at the 95th percentile (P95) was 195% of the ADI, and the highest intake was found in young boys – 200% of the ADI.

Conclusions. The average intake of sodium nitrite from meat products by Polish adolescents was generally lower than ADI. However, there was observed potential risk of excessive intake for some boys and girls who had a high consumption of meat products.

Keywords: *nitrites, intake, meat products, adolescents*

INTRODUCTION

The food additives: nitrites (E 249, E 250) and nitrates (E 251, E 252) can be used in strictly defined amounts in accordance with the EU Food Additives Regulation [1], in the selected meat product categories (nitrates and nitrites), and also to ripened cheeses (nitrates), processed fish and fishery products including molluscs and crustaceans (nitrates). Sodium nitrite (E 250) and potassium nitrite (E 249) as additives may be used at a dose of up to 150 mg/kg in meat products. In sterilised meat products, the permitted dose of E 249 and E 250 is 100 mg/kg. The amounts of nitrites that can be added to food are determined on the basis of toxicological studies in animals. The EFSA Expert Panel (ANS) set the Acceptable Daily Intake (ADI) for nitrite (expressed as nitrite ion) as 0.07 mg kg^{-1} day^{-1}, equivalent to 0.1 mg kg^{-1} day^{-1} of sodium nitrite [2].

According to the database of the FAOSTAT website, the consumption of meat (according to the food balance method) in 2018 was 43.1 kg/person/year in the whole world, while in Poland it was 8.4 kg/person/year. The latest data (year 2022) showed that meat consumption in the world was 44.6 kg/person/year. The result for Poland in the same year was 81.6 kg/person/year [3].

The Polish Household Budget Surveys data on consumption of meat and meat products in 2000 and 2020 showed that the consumption of these products decreased from 5.47 kg/person/month in 2000 to 5.09 kg/person/month in 2020 [4, 5]. The consumption of processed meat in 2020 was 1.96 kg/person/month

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and almost 90% of which was red processed meat. Twenty years ago, it was 2.04 kg/person/month [6].

The level of nitrite intake from meat products in the Polish population has been monitored for many years. The present study estimates the dietary intake of sodium nitrite in meat products by Polish adolescents and assesses the risk of exposure to this compound, taking into account data on intake and actual amounts of sodium nitrite in meat products.

MATERIAL AND METHODS

Dietary data were obtained from the Nationwide Dietary Cross-Sectional Survey in Poland, conducted from July 2019 to February 2020, among a nationally representative sample of adolescents (aged 11-17 years), according to the European Food Safety Authority (EFSA) guidelines on the EU Menu Methodology [7, 8]. The sodium nitrite content in the diets of 527 adolescents aged 11-17 years (265 boys and 262 girls) was estimated by age and sex, taking into account the weight of the respondents. Random sampling was used. Exclusion factors were: vegetarian diet, hospitalization and/or with an enteral and parenteral nutrition, mental condition which made impossible to obtain reliable information (neurodegenerative diseases, drunkenness, state after taking drugs and other substances stimulating) [9]. The dietary survey was conducted using the Album of Photographs of Food and Dishes [10]. The respondents were asked about food intake over the previous 24 hours. Both interviews were conducted during visits to the respondent's home and covered two non-consecutive days. The interval between the two interviews was at least seven days. The study was approved by the Bioethics Committee at the Institute of Food and Nutrition in Warsaw, Poland at 4 June 2018. A health risk assessment was based on the ADI as 0.07 mg kg^{-1} day^{-1} for nitrite ions, equivalent to 0.1 mg kg^{-1} day^{-1} of sodium nitrite [2]. The approach presented in the manuscript follows the methodology recommended by EFSA, for the creating of food additive intake data [7, 8]. This approach allows comparison of the results with other studies.

The data on sodium nitrite levels in food were obtained from chemical analyses of meat products (cold cuts, sausages, canned meat), ready-to-eat meals containing meat. These analyses were carried out in 2017 and 2018 by accredited laboratories of sanitary and epidemiological stations in 4 voivodships of Poland (Dolnośląskie, Lubelskie, Mazowieckie, Wielkopolskie). The content of nitrite in meat products was determined by spectrophotometric and HPLC method depending on laboratories [11]. The average content of sodium nitrite ($NaNO_2$) in the meat products was as follows: pork ham – 120 mg/kg, pork sausages – 7.5 mg/kg, poultry meat products – 15.6 mg/kg.

The Statistica® software was used for the statistical analyses. The distribution of sodium nitrite intake was checked with the use of Shapiro-Wilk test. The $p < 0.05$ statistical significance coefficient was adopted. The analysis of significance of differences in sodium nitrite intake between male and female respondents in the adult group was based on the nonparametric Mann-Whitney U test.

RESULTS

The analysis of consumption of meat products by 265 young boys and 262 young girls aged 11-17 years and the actual content of sodium nitrite in meat products showed that the overall sodium nitrite intake by adolescents was 0.063 mg kg^{-1} day^{-1} (0.066 mg kg^{-1} day^{-1} for boys and 0.059 mg kg^{-1} day^{-1} for girls) (Table 1). The above described parameters

Table 1. Sodium nitrite (E 250) content (mg kg^{-1} day^{-1}) in the diets of adolescents aged 11-17 years studied in 2019-2020 and the percentage of ADI

Gender	N	X	Me	Range	SD	P95	p (U-Mann-Whitney test)*
Daily intake (E 250) (mg kg^{-1} day^{-1})							
Boys	265	0.066	0.052	0-0.305	0.064	0.2	> 0.1
Girls	262	0.059	0.046	0-0.313	0.063	0.186	
Total	527	0.063	0.05	0-0.313	0.064	0.195	
% of ADI							
Boys	265	66.1	51.7	0-305	63.8	200	> 0.1
Girls	262	59.4	45.6	0-313	63.5	186	
Total	527	62.8	49.6	0-313	63.7	195	

N – number of respondents; X – mean; Me – median; SD – standard deviation; P95 – 95 percentile; * – statistically significance coefficient, $p < 0.05$; ADI – 0.1 mg kg^{-1} day^{-1}

Table 2. Sodium nitrite (E 250) content (mg kg^{-1} day^{-1}) in the diets of the studied adolescents aged 11-17 consuming meat products ("consumers only")

Gender	N	% in relation to total respondents	X	Me	Range	SD	P95	p (U-Mann-Whitney test)*
Daily intake (E 250) (mg kg^{-1} day^{-1})								
Boys	217	81.9	0.081	0.071	0-0.305	0.062	0.223	> 0.1
Girls	203	77.5	0.077	0.065	0-0.313	0.062	0.209	
Total	420	79.7	0.079	0.067	0-0.313	0.062	0.211	
% of ADI								
Boys	217	81.9	80.7	70.9	0-305	61.6	223	> 0.1
Girls	203	77.5	76.7	65	0-313	62.2	209	
Total	420	79.7	78.8	66.9	0-313	61.9	211	

N – number of respondents; X – mean; Me – median; SD – standard deviation; P95 – 95 percentile; * – statistically significance coefficient, $p < 0.05$; ADI – 0.1 mg kg^{-1} day^{-1}

did not exceed the ADI. The mean sodium nitrite intake was 66.1% of the ADI in the group of boys and 59.4% of the ADI in the group of girls. However, sodium nitrite intake at the P95 was 195% of the ADI for all subjects. The highest intake was found in boys – 200% of the ADI.

The data from the group of young people consuming meat products ("consumer only" group – 420 persons: 217 boys and 203 girls) was almost 80% of the total studied subjects (Table 2). The average intake of sodium nitrite was 0.079 mg kg^{-1} day^{-1} (0.081 mg kg^{-1} day^{-1} for boys and 0.077 mg kg^{-1} day^{-1} for girls), which represented an average of 78.8% of the ADI for all adolescents (80.7% of the ADI for boys and 76.7% of the ADI for girls).

In the assessment of intake and risk of exposure to $NaNO_2$, there were specified the groups of food products that are sources of sodium nitrite in the diet. Figure 1 shows the percentage of food groups that are

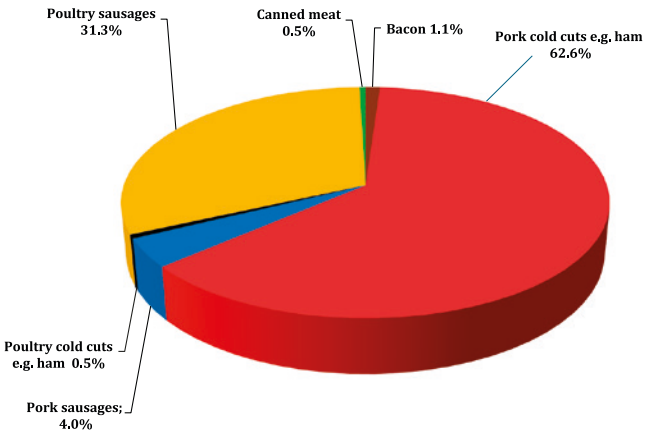

Figure 1. Percentage share of meat product groups as a source of sodium nitrite in the diets of the young respondents (11-17 years)

sources of E 250 in the diets of young Poles. The data show that more than half (62.6%) of the sodium nitrite in the diet of the Polish adolescents came from cured products – pork cold cuts, e.g. ham, and 31.3% from poultry sausages.

DISCUSSION

Considering the data on nitrite intake from meat products by young consumers (11-17 years) in Poland (total group), it should be noted that in the years 2019-2020 the exposure to sodium nitrite was 0.066 mg kg^{-1} day^{-1} for boys and 0.059 mg kg^{-1} day^{-1} for girls. In the same group of young Poles (11-17 years) in 2000, exposure was 0.015 mg kg^{-1} day^{-1} for boys and 0.013 mg kg^{-1} day^{-1} for girls [12]. This indicates that consumption of meat products has increased over this years. It should also be added that the assortment of meat products containing nitrites has increased during these years. Also the surveys in 2019-2020 shows a large percentage of adolescents consumed meat products (81.9% of boys and 77.5% of girls), then in the 2000, where percentage of adolescents consumed meat products was 49% in group of boys and 51.7% in the group of girls [12]. Czech-Załubska et al. [13] reported that the dietary exposure to sodium nitrite in adolescents (12-17 years) in 2023 was 0.038 mg kg^{-1} day^{-1} (tier 3). However, it should be noted that these data include the actual concentrations of nitrites in cured meat products reported in the literature, together with their frequency of occurrence [13]. In our study, the nitrite content of meat products was obtained from laboratory tests as part of food inspection by laboratories of sanitary and epidemiological stations in 2017-2018.

Acceptable Daily Intake for this population group has changed over about 20 years. In 2000, the % of

ADI for young boys was 14.6% and for young girls 13.3% [12]. In our study using data from 2019-2020, % of ADI increased and was 66.1% (boys) and 59.4% (girls). The intake of sodium nitrite at the P95 level was doubled (200% of the ADI for young boys and 186% of the ADI for young girls). In 2000, P95 was 72.4% (boys) and 66.5% (girls) [12].

In the group "consumers only" (people consuming meat products) in 2019-2020 intake of sodium nitrites was 80.7% of the ADI (boys) and 76.7% of the ADI (girls). In 2000, the % of ADI in this group was 29.9% for boys and 25.8% for girls [12]. In this case, both studies assumed the same values for sodium nitrite in meat products (2017-2018 laboratory data), while using different consumption data, from 2000 [12] and from years 2019 and 2020.

Among the different types of meat products consumed by young Poles (11-17 years) more than 63% were smoked meat, including ham, and 35% were sausages. In the study by Czech-Załubska et al. [13] the data on meat product consumption were similar. Steamed smoked meats and wiener sausages and kabanos sausages were consumed the most.

It should also be added that the total dietary exposure of young people to nitrites may be higher because nitrites are also present in drinking water and other foods: cereal products (bread), dairy products including cheese. However, the levels of nitrite in the above-mentioned foods outside drinking water are often below the LOD (Limit of Detection) [14-17]. Similarly, Larson et al. [18] reports that consumer exposure to nitrite from drinking water is low and this source of nitrite often does not have a significant impact on estimated dietary nitrite intake.

Sodium nitrite is a compound that requires special attention in terms of risk assessment. $NaNO_2$ is added to meat as a nitrogen compound to maintain microbiological safety against the development of pathogenic bacteria such as *Clostridium botulinum* in meat products [2]. In recent years, some alternative meat preservation technologies have been developed that could reduce the use of nitrites (e.g. use of plant extracts or polyphenols in the production of meat products). However, until such substances are authorised, they cannot be used for meat preservation. According to the EFSA opinion, "meat and meat products" is the main food category contributing to the exposure to N-nitrosamines [19]. In an opinion of 2022, the French Agency for Health Safety (ANSES) recommended not to consume more than 150 g of meat products per week [20]. The American Institute for Cancer Research (AICR) and others experts recommend concluded that consumption of processed meat is a convincing cause of colorectal cancer [19-23]. Recently, as part of the work of the European Commission, consideration has been given to reducing the permitted doses of nitrites added to foods as additives – this applies to both meat products and ripened cheese. This will reduce these substances in food. Another way to reduce nitrite intake is to limit the consumption of cured meat products [24].

CONCLUSIONS

The average intake of sodium nitrite from meat products by Polish adolescents was 0.066 mg kg^{-1} day^{-1} for boys and 0.059 mg kg^{-1} day^{-1} for girls, which correspond to 66.1% and 59.4% of the ADI respectively.

Among some adolescents the high levels of sodium nitrite intake was observed at P95 (above ADI) in the group for boys and girls, as well.

Educational activities on balanced and varied diet with limited consumption of meat products can help to reduce the risk of excessive intake of nitrites.

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Conflict of interest

The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

EVALUATION OF THE DIET OF A SELECTED GROUP OF CHILDREN WITH COELIAC DISEASE

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ABSTRACT

Introduction. Gluten-free diet (GFD) is the only effective treatment for coeliac disease. The aim of GFD is to provide all necessary nutrients, excluding products containing gluten or products contaminated with it.

Objective. The aim of the study was to assess the diet of a selected group of children with coeliac disease by analysing the frequency of consumption of basic food groups.

Material and Methods. The study involved a group of 50 children between the ages of 1 and 10, whose parents completed food frequency questionnaires and a 7-day diary of current notes. The large age range precluded quantitative assessment of intake, so further analysis was qualitative. The assessment was based on the Diet Quality Indicators (DQI).

Results. The results indicated a low variety of vegetables consumed, especially raw, and the proportion of fruit and fruit preparations significantly exceeding the amount of vegetables consumed. The GFD was dominated by light gluten-free bread and rice and millet groats. The main sources of animal protein were meat and its products and eggs, there was a very low consumption of fish and low consumption of legumes and unsweetened fermented dairy drinks. Water, flavoured waters and fruit juices and drinks were the main liquids consumed in the study group of children. In school-aged children were observed to consume frequent (daily, several times a week) sweet snacks and toast. The majority of patients complied with the GFD, however, deviations were noted, of which the children's parents were informed.

Conclusions. The assessment of GFD quality in most of the studied children indicated a need to improve its quality, particularly in terms of increasing the intake of vegetables and reducing the intake of easily digestible carbohydrates. Regular monitoring of GFD quality and education of children and parents on the principles of GFD and proper nutrition.

Keywords: *coeliac, gluten-free diet, diet quality, DQI, children*

INTRODUCTION

The gluten-free diet (GFD) is currently the only effective treatment for celiac disease [1]. The aim of applying GFD is the skilful use of gluten-free raw materials and food products, providing all the necessary nutrients, while excluding products containing or contaminated with gluten [1, 2].

The proper balance of a gluten-free diet ensures the regeneration of the intestinal mucosa and also improves the nutritional status of patients. Strict and rigorous adherence to the dietary regime can protect the patient from serious health consequences [1]. A properly managed elimination diet requires the absolute avoidance of foods derived from and/or containing wheat, barley and rye, as well as oats, which can be cross-contaminated with gluten-forming proteins during harvesting and processing [3].

The GFD, individually tailored to the patient's needs, should include products from all parts of the healthy eating plate (or the nutrition and physical activity pyramid, depending on the patient's age group), including whole grain cereals and gluten-free pseudo-cereals. Inadequate dietary balance can result in an overconsumption of animal fats and proteins relative to complex carbohydrates, which can cause people with coeliac disease to develop overweight or obesity [1, 4, 5]. In addition, gluten-free products may be derived from raw materials with a high degree of processing (e.g. refined flours), a high glycaemic index and with a significant content of fats (including saturated fatty acids and trans fatty acid isomers) and simple sugars and salt. The above factors, combined with the long-term use of a non-nutritional GFD in which substitutes containing selected nutrients are not used, will exacerbate nutritional

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deficiencies in the patient. However, routine dietary supplementation is not recommended, with the exception of common recommendations for vitamin D. Dietary supplementation should be considered on an individual basis depending on the nutritional status of the patient and should always be carried out under the supervision of a physician and dietician [1, 5-7].

Studies of the diet and health quality of the diet of patients with coeliac disease carried out in various countries have shown it to be improperly balanced, but similar observations also apply to the population of healthy people. However, consistent use of the GFD improves the quality of life of patients and prevents the occurrence of disorders such as osteoporosis, anaemia or obesity, as well as reducing the risk of gastrointestinal cancers [1, 5, 7].

Consistent application of the GFD leads to the regeneration of intestinal villi, improves the quality of life of patients, removing complaints such as abdominal pain, flatulence, loose stools. In the paediatric population a well-balanced GFD can prevent the occurrence of disorders such as osteoporosis, anaemia or obesity, and in adults it can also reduce the risk of gastrointestinal tumours [1-7].

MATERIAL AND METHODS

The study included a group of 50 children aged 1 to 10 years and their parents. Eight patients had been diagnosed at least more than 4 years earlier, 32 children had been diagnosed in the last 3 years and the 10 youngest patients (14-28 months old) had been diagnosed at least 3 months earlier. All patients implemented the GFD after diagnosis and followed it under medical supervision, but without consulting a dietician.

The caregivers and parents of the children included in the study consented to the anonymous use for scientific purposes of data obtained from the current diary and the food frequency as well as to the use of information on the child's age, gender, weight and height. The study was approved by the Bioethics Committee at the University of Rehabilitation Sciences, Warsaw, Poland. Data were collected between 2014 and 2024.

The mean age of the children surveyed at recruitment was 5 years (range 14 months of the year to 10 years). The large age range prevented a reliable quantitative assessment of dietary intake for the patient group, so further analyses of diet were only concerned with qualitative assessment. Dietary assessment was based on a completed:

- a diary of current note-taking (7-day), prepared by parents prior to consultation with a dietician based on detailed instructions for completion and accompanying tables of home measures;
- questionnaire of frequency of habitual consumption of basic groups of products, including: gluten-free sweets and snacks, dairy products and eggs, gluten-free cereal products, fats, fruits, vegetables and grains, meat products and fish, beverages Frequency of consumption was defined at: 'several times a day', 'daily', 'several times a week', 'several times a month', 'once a month or infrequently' or 'never or almost never' – filled out at the time of the dietetic consultation, using the face-to-face interview method.

To assess the quality of children's diets, the Diet Quality Index (DQI) [8, 9] was used. The DQI assesses various elements of diet, including: dietary variety, adequacy and balance, and meal index. Dietary variety was reflected by daily consumption of at least one product from each of the food groups recommended by Polish guidelines [10]. The study assessed an assortment of 59 foods grouped into 8 food groups, the frequency of intake was summed and, within each food group, subjects were divided into '1' (intake ≥ 1 time/day) or '0' (intake < 1 time/day). After calculating the diversity score for each food group, the diversity scores were summed, divided by 8 (i.e. the number of food groups) and multiplied by 100.

The next component of the DQI, i.e. diet quality, was estimated based on the average energy and nutrient density of each food item, values based on the tables of composition and nutritional value of food [11, 12]. Food products:

- for which a limited intake is recommended for (e.g. gluten-free sweet or salty snacks, sweetened soft drinks), were rated '-1';
- which are classified as 'recommended foods' (e.g. fresh vegetables, gluten-free cereal/full grain gluten-free bread), were rated '1';
- whose consumption is recommended in moderation (e.g. light gluten-free bread, yoghurt with added sugars) were scored as '0'.

Each score was then multiplied by the average daily intake (g or ml) of the corresponding food, and all scores were summed, divided by the total amount of food consumed (g or ml) and multiplied by 100.

For the third element of the DQI, dietary balance, the intake of each food group (the sum of the intake of all foods that fell into a given food group) was compared with the recommendations (Pyramid of Healthy Eating and Lifestyle for Children and Adolescents [10]) to estimate 'compliance' and 'moderation'.

An algorithm according Androutsos et al. [12] was used to calculate the compliance intake for each food group. Compliance for each food group was scored as '1' when the daily intake for the selected food group products included the 'minimum recommended

intake' or was calculated according to the formula – daily food group intake/minimum food group standard when the daily intake did not include the minimum recommended intake.

Moderate intake for an individual food group, this was scored as '0' when the food group's daily intake did not exceed the maximum recommended intake, as '-1' when the food group's daily intake was twice or more than the maximum recommended intake and as [(maximum standard – food group's daily intake)/ maximum standard] when the food group's daily intake exceeded the maximum recommended intake [11, 12].

The total 'diet balance' score was the sum of all adequacy and moderation scores divided by the total number of food groups and multiplied by 100.

The fourth item assessed in the DQI was the meal index. In the analysis, it was calculated by dividing the average number of meals and then multiplying by 100.

The total DQI was calculated according to the following equation [11, 12]:

Total DQI = ('diet variety score' + 'diet quality score' + 'diet balance score' + 'meal index')/4

Parents also reported other lifestyle behaviours of their children by means of comments in a running diary, such as the type and frequency of physical activity of the child (possible answers: '1 time/week', '2 times/week', '3 times/week' or '> 3 times/week').

The STATISTICA PL 13.0 package was used for statistical analysis. Continuous characteristics were presented as mean [standard deviation (SD)] and categorical characteristics as relative frequencies (%). One-way analysis of variance (ANOVA) was used to test the association between diet quality indicators and age group (1-3, 4-7, 7-10 years), an independent Student's t test was performed to test the association between diet quality indicators and gender of children (boys, girls). The significance level was set at $\alpha = 0.05$.

RESULTS

The characteristics of the children are shown in Table 1. The majority of the children in the study group (80%) were pre-school and school-aged, and more than 60% were girls. Only more than 40% of the children in the study group had physical activity declared by their parents at least three times a week; however, it should be noted that parents of children aged 1-5 years had difficulty in defining the physical activity of their children, who performed physical games at home, nursery or kindergarten, but these were regarded by carers and parents as 'having fun' rather than 'physical activity' and a form of recreation, so indications may be underestimated. There was greater agreement in the assessment of children's physical activity among parents of school-age patients, where physical education classes and additional extra-curricular activities were included in activity (in girls, rhythmics, dance and acrobatics, and in boys, rhythmics and football).

Table 1. Descriptive statistics of the N = 50 coeliac children's characteristics

Demographic characteristics	N (%)
Age	
1-3 years old	10 (20)
4-6 years old	32 (64)
7-10 years old	8 (16)
Gender	
girls	32 (64)
boys	18 (36)
Frequency of physical activity	
1 time/week	9 (18)
2 times/week	20 (40)
3 times/week	14 (28)
> 3 times/week	7 (14)

The data obtained (Table 2) indicated that there was little variety in the vegetables consumed, especially raw vegetables. Most of the children received raw vegetables only a few times a week and usually recur within the same range (mainly tomatoes and cucumbers, less often paprika, radishes and different types of lettuces). On the other hand, carrots, broccoli, cauliflower and beetroot appeared among the cooked vegetables, which were mainly found in lunch dishes, rarely in the form of a hot dinner, unless it was a reheated dinner. The proportion of fruit and processed fruit products (mainly fruit mousses) significantly exceeded the amount of vegetables consumed.

In general the GFD was dominated by gluten-free light breads, rice and millet groats. The parents of the children surveyed rarely and/or very rarely gave their children whole-grain gluten-free bread. However, it should be noted that the data for the study were collected over a long period of time. About 10 years ago, the range of gluten-free wholemeal bread in Poland was very small, which underestimates the obtained result, since the data of the last 4 years indicated an increase in the consumption of gluten-free bread from wholemeal flour and sourdough.

The main sources of animal protein were meat and its products and eggs, there was a very low intake of fish and a low intake of legumes and unsweetened fermented dairy drinks. It is noteworthy that the youngest children frequently consumed processed

Table 2. Frequency of consumption of selected product groups (% of group)

Frequency (%)	Raw vegetables	Cooked vegetables	Fruits	Juices	Wholemeal bread*	White bread*	Breakfast cereals	Meat	Cured meat	Fish	Eggs	Milk	Milk products	Animal fats	Vegetable fats	Sweets
Several times a day	6	10	38	8	6	46	2	0	36	0	6	10	22	36	4	28
Daily	34	68	48	26	4	36	20	60	34	0	12	24	60	28	20	54
Several times a week	54	16	10	40	6	10	54	30	20	4	54	54	14	26	64	14
Several times a month	2	6	4	16	18	4	16	6	6	6	20	8	2	6	4	4
Less than once a month	4	0	0	6	36	4	8	2	2	70	6	2	0	2	6	0
Never or hardly ever	0	0	0	4	30	0	0	2	2	20	2	2	2	2	2	0

* – gluten-free

meat products, which included cold cuts (high-quality and minced), as well as sausages, kabanos and wieners, the latter appearing in the children's diet even several times a day. The vast majority of children did not consume fish or fish products. If fish appeared in children's menus (at home or in pre-school and school canteens), it was breaded in gluten-free breadcrumbs and fried, less frequently baked or stewed.

Among fermented dairy drinks, fruit yoghurts with added sugar predominated, and parents noted the difficulty of finding a range of products that were labelled gluten-free and tasted good to their children. Other fermented dairy drinks were rarely used, especially those with natural flavours. However, parents were attentive to the nutritional claims on dairy product labels, looking for those that (in addition to the gluten information) advised on the presence of calcium in the product.

Rarely did legumes appear in children's diets, mainly in the summer season (green beans, broad beans or sugar snap peas), and very rarely did their dry seeds appear. Parents pointed out, not only the reluctance of (children and/or parents) to eat this assortment group due to the risk of bloating and gas, but also the lack of skill in preparing tasty dishes and the difficulty in finding products that did not contain the manufacturer's declaration of gluten contamination.

Among fats in children's diets, animal fats and vegetable fats for bread spreads predominated. With sandwiches appearing frequently in the diet (e.g. in school-aged children), fat consumption increased.

Water, flavoured waters and fruit juices and drinks were the main liquids consumed in the study group of children. Attention is drawn to the frequent consumption of fruit juices, which, according to the parents, could replace a portion of fruit and vegetables. In most cases, these were juices bought by the parents and, less frequently, squeezed by themselves. Over the course of the study, the popularity of pressed juices increased among children, which were consumed more frequently and in larger volumes.

Frequent (daily, several times a week) consumption of sweet snacks and toast with cheese was observed in school-aged children. Parents pointed out in their comments on the frequency of consumption questionnaire that there was plenty of access to a range of gluten-free sweets and they were readily available. In addition, there was a habit in some families of leaving sweets in a place accessible to all members of the household and a lack of clear control over the amount of sweets consumed by children.

The majority of patients adhered to the gluten-free diet, but deviations were noted, of which the children's parents were informed.

Table 3. Diet quality score based on weekly consumption of food groups

Diet quality score [Mean (SD)]:	Age			p[1]	Gender		p[2]
	1-3 years	4-6 years	7-10 years		girls	boys	
Dietary diversity	51.8 (13.46)	35.5 (15.25)	32.5 (14.49)	< 0.05	47.3 (17.06)	36.1 (22.3)	< 0.05
Dietary quality	52.3 (15.79)	43.8 (15.79)	41.4 (13.16)	0.056	48.1 (12.36)	43.6 (12.2)	0.49
Dietary equilibrium	42.8 (14.52)	34.6 (13.85)	33.2 (13.63)	0.365	38.6 (14.02)	36.7 (17.4)	0.308
Meal index	78.7 (11.4)	73.3 (11.71)	77.5 (11.9)	0.114	76.7 (10.9)	77.3 (10.8)	0.217
Total Diet Quality Index (DQI)	56.4 (10.70)	46.8 (12.87)	46.15 (11.44)	< 0.05	52.6 (9.98)	48.4 (11.49)	< 0.05

[1] p-value was based on One-way Analysis of Variance (ANOVA); [2] p-value was based on the Independent samples t-test

As shown in Table 3, there was no significant difference between the three age groups, with the exception of dietary variety ($p < 0.05$), with children aged 1-3 years showing the highest values (51.8%) compared to the other age groups. This difference can be explained by the fact that it was mainly the parents who were responsible for the preparation of the meals and the selection of the range of raw materials, whereas in the older groups, e.g. the predominantly pre-school and kindergarten age group, the children ate most of their meals in the canteen. The same age group seemed to have the highest mean total DQI value (56.4%), but despite no differences between age groups. Regarding differences by gender, girls had significantly higher mean values in dietary balance scores (girls vs. boys – 47.3% vs. 36.1%; $p < 0.05$), for the other items and the DQI no differences were observed.

DISCUSSION

In this study, the quality of the gluten-free diet was assessed using the DQI for a group of 50 children aged 1-10 years. Subgroup analyses showed that the youngest children (aged 1-3 years) had the highest dietary balance values compared to older children (aged 4-7 and 7-10 years). It was observed that for the majority of children (irrespective of age and gender) the quality of the gluten-free diet should be considered sufficient or poor. A weakness of the study was the large variation in the age groups of the studied children with a small sample and the long time of data collection, which resulted in some of the observations concerning the range of gluten-free foods (including breads, breakfast concentrates, cured meats) having undergone significant changes, including the composition and nutritional value of the products and their availability. However, there is the clearly continuing trend of low consumption of vegetables, fish and unsweetened fermented milk drinks by children. In addition, adherence to a gluten-free diet can be challenging for parents who, prior to their child's diagnosis, lacked knowledge and culinary experience in this area. Therefore, testing the overall quality of the diet (and assessing the nutritional value of the diet) can provide representative results to prepare nutrition education for parents and effective assistance in changing the child and family's eating habits and habits [1, 5, 6, 13].

Children (and adolescents) using GFDs are more likely to have an insufficient intake of fibre [14, 15] folic acid, magnesium, selenium and vitamin D [1, 14, 15]. This is related to two factors gluten-free food quality and diet. The impact of food technology on the quality of gluten-free (processed) products is known, e.g. the removal of fibre in the purification of cereal grains and pseudo-cereals. However, it should be borne in mind that fibre is water-absorbent and its presence in the product, which may interfere with texturizing processes shaped using hydrocolloids, which are used as gluten substitutes. In a Mager et al. [16] study involving more than 240 children with coeliac disease, the majority of subjects followed dietary patterns typical of a 'western diet' or 'high-fat western diet', while < 20% of children followed a healthy 'prudent' dietary pattern. In addition, frequent consumption of highly processed foods in children with coeliac disease was associated with an increase in pro-inflammatory markers. In adolescents, on the other hand, a high intake of gluten-free light bread, confectionery products, as well as sweet and salty snacks was associated with the risk of steatohepatitis associated with metabolic disorders [1, 17-18]. To this should be noted the higher intake of saturated and hydrogenated fats, as well as sugars (also from mousses and fruit juices) compared to children on a gluten-containing diet [1, 13-17, 19].

The latest recommendations for a healthy gluten-free diet do not differ from those for a healthy conventional diet, but the need to expand children's diets to include a group of naturally gluten-free pseudo-cereals, seeds, grains and seeds has been identified. It is recommended that naturally gluten-free products such as gluten-free whole grains and flours, pseudo-cereals, legumes and tubers (e.g. potatoes) become the main sources of carbohydrates. The US Departments of Health and the US Department of

Agriculture have recently proposed a healthy eating pattern that includes [1, 20]:

1. two to three portions of vegetables/day
2. two to three portions of fruit/day
3. three to six servings of cereals/day (gluten-free)
4. two portions of milk and/or dairy/day
5. one to two portions of protein sources (animal or vegetable equivalent)/day
6. five to seven portions of nuts/week
7. at least one to two portions of legumes/week.

These proportions reflect the recommendations of the Healthy Eating Plate [10, 21] – including ½ plate for fruit and vegetables, ¼ plate for protein sources and ¼ plate for carbohydrates.

Nutrition education for children and their families, adherence to recommendations for GFD enrichment can facilitate dietary adherence and have a long-term impact on improving the quality of life and health of patients with coeliac disease.

CONCLUSIONS

Regular supervision of the quality of the diet and education of children and parents on the principles of gluten-free diet and proper nutrition is necessary. Evaluation of the quality of the gluten-free diet in the majority of the children studied indicated a need to improve its quality, particularly in terms of increasing vegetable intake and reducing the amount of easily digestible carbohydrates consumed.

Conflict of interest

Author declares no conflicts of interest.

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INSTRUCTION FOR AUTHORS

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Manuscript arrangement

Manuscripts submitted for publication should be prepared in doc, docx, rtf formats using Microsoft Word Times New Roman 12 font and 1.5 space between lines on A4 format.
Manuscript should include: (1) title page, (2) text of the manuscript, (3) Tables, (4) Figures, (5) Appendices. A complete manuscript should not exceed 16 pages, including text, tables, figures and references.

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Original research article should be divided into the sections: Introduction/Background, Material and Methods, Results, Discussion, Conclusions, Acknowledgements, Conflict of interest and References.

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The examples of reference style are given below:

Journal article with 1-6 authors:

1. Mertens E, Colizzi C, Peñalvo JL. Ultra-processed food consumption in adults across Europe. Eur J Nutr. 2022;61(3):1521-1539. doi: 10.1007/s00394-021-02733-7.

Journal article with more than 6 authors:

2. Osei-Kwasi HA, Boateng D, Danquah I, Holdsworth M, Mejean C, Terragni L, et al. Acculturation and Food Intake Among Ghanaian Migrants in Europe: Findings From the RODAM Study. J Nutr Educ Behav. 2020;52(2):114-125. doi: 10.1016/j.jneb.2019.09.004.

Book:

3. Kerner S, Chou C, Warmind M. Commensality: From Everyday Food to Feast. London: Bloomsbury Publishing PLC; 2015. ISBN 9780857857361.

Book chapter:

4. Lucas BL, Feucht SA. Nutrition in childhood. In: Mahan LK, Escott-Stump S, editors. Krause's Food & Nutrition Therapy. 12th ed. St. Louis, MO: Saunders Elsevier; 2008. p. 222–245. ISBN 9780808923787.

Internet source:

5. World Health Organization. GHE: Life expectancy and healthy life expectancy [Internet]. Geneva: World Health Organization; 2024. [cited 2024 Jan 19] Available from: https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-life-expectancy-and-healthy-life-expectancy.

Legislative acts:

6. Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives (Text with EEA relevance). OJ L 354, 31.12.2008, p. 16–33. Available from: http://data.europa.eu/eli/reg/2008/1333/oj.

Tables should be prepared in separate file(s) in doc, docx, rtf, odt formats and numbered using Arabic numerals. The title should be place directly above each table. Tables should always be cited in the text in consecutive numerical order. Each column in tables should have a brief heading, more extensive explanation should be given below the table, if necessary. The number of tables should be limited to the necessary minimum.

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Abbreviations, symbols, units. Generally known and used abbreviations may be left unexplained, others must be explained at the first use in the text. Metric SI units are recommended, however also other generally used units are accepted.

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The Editors would like to thank all the Reviewers for their invaluable contribution to the review of manuscripts submitted for publication in the journal Roczniki Państwowego Zakładu Higieny (Annals of the National Institute of Hygiene). Without your efforts and cooperation, it would not be possible to maintain the high quality of the journal.

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