

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]:

$$\text{Total DQI} = ('diet\ variety\ score' + 'diet\ quality\ score' + 'diet\ balance\ score' + 'meal\ index')/4$$

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

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) |

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, rhythmic, dance and acrobatics, and in boys, rhythmic and football).

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 $\frac{1}{2}$ plate for fruit and vegetables, $\frac{1}{4}$ plate for protein sources and $\frac{1}{4}$ 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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