Is compliance with gluten-free diet sufficient? Diet composition of celiac patients

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This study was planned to investigate the amount and content of foods consumed by child patients with celiac disease on a long-term gluten-free diet.

Children aged 3-18 years who were diagnosed with celiac disease according to ESPGHAN criteria and were compliant to the gluten-free diet for at least one year were included. Age and gender matched healthy children were included as the control group.

Food consumption records including the amount and content of the foods consumed for a total of three days were obtained. Once the records had been completed on the food consumption form, quantity analysis was again performed by the same dietician. Energy and other nutritional elements taken in through foodstuffs consumed by the patient and control groups were calculated using the Nutrition Data System for Research Package; these results were shown as mean ± standard deviation (x ±SD) and the values compared.

The study consisted of 28 patients with a mean age of 10.3 ± 4.6 and 25 healthy controls with a mean age of 9.5 ± 3.4. Average age at diagnosis in the patient group was 6.7 ± 4.3 and mean duration of gluten-free diet was 4.0 ± 3.3 years.

Children with celiac disease on a gluten-free diet had significantly lower daily energy intake levels compared to the healthy controls ($p<0.05$). The proportional fat consumption was significantly higher in the patient group compared to the controls ($p<0.05$). Moreover, proportional carbohydrate and protein, vitamin E and vitamin B1, and microelements such as magnesium, phosphorus and zinc consumptions were significantly lower in celiac group with respect to v-control group.

Solely determining compliance to the gluten free diet might be inadequate in the follow-up of children with celiac disease, adequacy of the nutritional content in terms of macro and micronutrients of celiac disease patients is also important.

Key words: celiac disease, children, gluten-free diet.

Celiac disease is an autoimmune disease resulting in damage to the intestinal mucosa and malabsorption following a series of immunological processes triggered by gluten consumption found in wheat, barley and rye. Prevalence studies in Western Europe and the United States of America have shown an incidence of 1:150 to 1:300[1,2]. Similar results have been reported in prevalence studies in Turkey[3,4].

The main treatment method of celiac disease is the removal of gluten containing foods from the diet. The fact that gluten-free products might

not taste particularly pleasant or might not be easily available leads to children and adolescents with celiac disease to develop different and imbalanced nutritional habits and diets[5-10]. On the other hand there are some debates on the adequacy of micronutrient composition of gluten free diet[10].

This study was aimed to investigate the amount and content of foods consumed by children with celiac disease on a long-term (at least 1 year) gluten-free diet (GFD) and to compare it with healthy children.

Material and Methods

This study was performed between March 2009 and May 2010 at the Hacettepe University Faculty of Medicine İhsan Doğramacı Children's Hospital, Department of Pediatric Gastroenterology, Hepatology, and Nutrition.

Three to 18 years old children with celiac disease who were on GFD for at least one year were included in the study. Compliance with GFD was confirmed by dietary history, and by anti-endomysium (EMA) IgA antibody. Non-compliant children and children with IgA deficiency were excluded.

Patient monitoring was performed at the clinic by a pediatric gastroenterology specialist, at three-month intervals in the first year and six-months thereafter. The control group consisted of healthy, age- and gender-matched children with no selective IgA deficiency or EMA IgA positivity.

Three-day recording and analysis of food consumption

Food consumption records for a total of three days (two days mid-week, one day weekend) were requested from the family and children when appropriate. For that purpose, a standard food consumption form was designed to record variety and amount of foods consumed at each meal. A dietician explained and trained families and patients on how to record data on the food consumption form, with the use of a visual dietary catalogue. Once the records have been completed, analyses were again performed by the same dietician. Mean daily caloric intake, macro and micronutrient consumption were calculated using the Nutrition Data System for Research Package and was expressed as mean ± standard deviation (x ±SD).

Ethical approval:

Ethical approval for this study was obtained from the Hacettepe University Medical Faculty Local Ethical Committee.

Statistical Analysis:

Patient and control group demographic characteristics and daily food intake were compared with SPSS 16.0 program by using the t-test and Mann-Whitney U test. Pearson correlation analysis was used to determine correlations between dietary intakes and lipid profile and serum electrolyte and vitamin levels. Statistical significance was set at $p<0.05$.

Results

The study consisted of 28 patients (22 female, 6 male) with a mean age of 10.3 ± 4.6 years and 25 healthy controls (18 female, 7 male) with a mean age of 9.5 ± 3.4 years. There were no differences between groups in terms of age and gender distribution. Average age at diagnosis in the patient group was 6.7 ± 4.3 years and mean duration of GFD was 4.0 ± 3.3 years. Gender has no effect on daily food intake in either group. Duration of diet did not affect daily food intake parameters.

Children with celiac disease had significantly lower daily caloric intake compared to the healthy controls ($p<0.001$) (Table I). Percentage of fat contributing to the daily caloric intake was higher in children with celiac disease compared to the controls ($p=0.003$). Percentage distribution of total daily calories were given in Fig. I. There were other deficits in terms of vitamin and micronutrient intakes of celiac children.

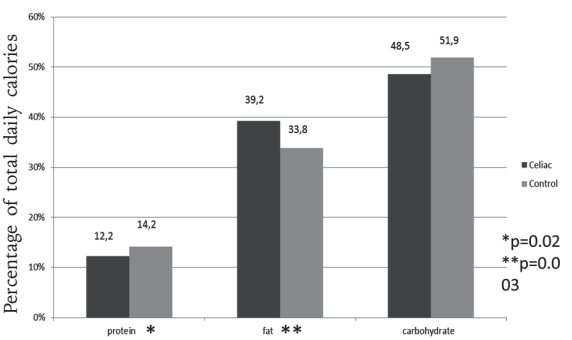

Fig. 1. Distribution of daily calories according to the study group

Discussion

Gluten free diet is the standard treatment for celiac disease. Compliance with GFD results in clinical, serological and histopathological resolution as well as malabsorption-associated problems such as growth retardation[11-13]. However nutritional deficiencies were still described in patients with celiac disease who had adhered to GFD[7,14]. These findings raised questions about nutritional adequacy of GFD[15]. The data on this subject in the scientific literature are limited. Diet contents might differ from one country to another, depending on populations' dietary habits and food sources. There are no studies investigating whether or not Turkish children with celiac disease are sufficiently well nourished with GFD.

Patient group protein and carbohydrate consumption in our study was lower compared to that of the healthy children, while there was no difference in quantitative fat consumption. Individuals in the patient group had lower daily energy intake compared to the healthy controls. The percentage of energy obtained from fats was significantly higher in the celiac group. These findings are in agreement with those of other studies in the literature. Ferrara et al.[16] investigated daily levels of energy and fat intake in a study of 50 children with celiac disease on a GFD and 50 healthy children. Children on GFD consumed significantly higher levels of fat compared to the healthy controls. They reported that this was especially evident in pubertal girls. Capristo et al.[5] investigated alterations in composition and energy metabolism in celiac disease patients with pre-and post-therapy measurements. Pre-gluten-free diet therapy body weight was lower in the patient group, while carbohydrate oxidation rate was higher. Carbohydrate oxidation rate was correlated with fecal fat loss. They also observed that lipid intake and body fat levels rose post-gluten-free therapy[5]. Increased incidence of obesity has been reported in celiac patients following gluten-free diet[17]. Our results show

Table I. Patient and Control Group Food Contents

	Patient group (n=28)	Control group (n=25)	P value
Energy (kcal)	1582.7±419.4	1921.8±321.2	0.002
Protein (g)	45.5±12.9	66.3±12.5	<0.001
Fat (g)	68.7±19.1	72.7±16.6	0.4
Poly-unsaturated (g)	18.7±6.9	13.2±6.5	0.005
Carbohydrate (gr)	190.0±68.2	244.8±53.4	0.002
Fiber (g)	13.8±7.0	20.1±5.7	0.001
Cholesterol (mg)	282.7±120.4	335.6±120.7	0.1
Vitamin A (μg)	1035.0±1227.9	1091.6±1236.1	0.8
Vitamin E (mg)	19.7±6.5	14.3±6.5	0.004
Vitamin B1(mg)	0.6±0.1	0.8±0.1	<0.001
Vitamin B2(mg)	1.2±0.3	1.3±0.3	0.1
Vitamin B6(mg)	1.2±0.3	1.4±0.4	0.06
Folic acid (mg)	269.5±98.5	292.8±77.8	0.3
Vitamin C (mg)	126.3±71.1	101.1±51.2	0.1
Sodium(mg)	972.7±363.3	1655.5±822.8	<0.001
Potassium(mg)	2232.2±756.2	2467.8±703.0	0.2
Calcium(mg)	653.5±280.3	645.1±259.0	0.9
Magnesium(mg)	200.5±68.3	247.6±65.3	0.01
Phosphorus(mg)	899.6±247.7	1088.8±223.8	0.005
Iron(mg)	6.9±2.6	11.2±3.2	<0.001
Zinc(mg)	5.9±1.8	9.2±2.1	<0.001

that daily food intake balance is impaired in favor of fats. Greater fat consumption is correlated with many disorders, particularly atherosclerotic diseases. In short term GFD seems to decrease the risk factors associated with celiac disease[18]. However on the long run, adults with celiac disease with good metabolic control showed increased carotid intima media thickness which is accepted as a sign of subclinical atherosclerosis[19]. The data from this study revealed that great care needs to be taken in order to prevent later atherogenic problems.

Consumption of unrefined cereals is an important source of calories and fiber. On the other hand, cereal consumption reduces polysaturated fatty acid and cholesterol intake[20]. Kupper et al.[17] reported that fiber consumption declined significantly and fat consumption rose in patients on GFD. In this study, fiber consumption was also significantly lower in Turkish children with celiac disease on GFD for more than one year compared to healthy children. This reveals the importance of consuming gluten-free fiber rich foods in order to prevent problems that may arise from low fiber consumption in these patients.

Digestion and absorption functions are affected by the increased immune activation in the intestinal system in patients with celiac disease, and may be insufficient. In addition, these functions do not fully revert to normal following adoption of GFD. Individuals with celiac disease are more prone to pancreatic insufficiency, lactose intolerance, and folic acid, vitamin B12, vitamin D and iron deficiency. Even if they follow a strict GFD, supplementary nutritional support is still needed in order to prevent a great many complications arising[21] Hallert et al.[22] examined vitamin levels by measuring homocysteine level and folic acid, B12 and B6 substrates in patients following GFD for 10 years. They determined low vitamin levels in approximately half of adult patients on a very strict GFD. They observed high homocysteine levels and a high incidence of cardiovascular disease in patients with low vitamin levels and emphasized that vitamin levels must be monitored in celiac disease patients. In another study, researchers have given vitamin B12, B6 and folic acid combination to adult celiac patients on long-term GFD. After 6 months they observed a significant improvement in the general health of patients administered vitamin therapy and recommended that vitamins be given to all patients[23]. Presutti et al.[24] stated that patients with celiac diseases should be examined for osteoporosis, thyroid dysfunction and folic acid, vitamin B12, fat soluble vitamins and iron deficiency and that these can be overcome with appropriate treatment together with GFD. Hozyasz et al.[25] showed that vitamin E levels return to normal after GFD. In this study patients were found to consume enough vitamin E. On the other hand, patients' consumption of vitamin A, carotene, vitamins B1, B2, B6 and folic acid were lower compared to the control group. Our results suggest that it will be useful to give child celiac disease patients vitamin A and vitamin B complex. However the duration of supplementation needs to be determined.

Kupper et al.[17] reported that gluten-free products were often low in vitamin B, calcium, vitamin D, iron, zinc, magnesium and fiber, that very few gluten-free foods were supplemented. Therefore, even if newly diagnosed celiac disease patients and those receiving inadequate treatment do comply with the diet, low bone mineral density, imbalance in micronutrients, low fiber intake and micronutrient deficiency are still observed. Low bone mineral density is frequently encountered in celiac patients. This is probably due to calcium and vitamin D absorption deficiency, proinflammatory cytokine release and imbalance in bone formation. Bone loss is widely encountered in Type I DM, autoimmune thyroid diseases and celiac disease, and is generally regarded as a complication of these[21, 26]. Some researchers have reported that bone mineral density improves following a gluten-free diet and that bone growth process returns to normal[27]. The data obtained from this study show that although patients on gluten-free diets in Turkey receive sufficient calcium, their intake of iron, zinc, phosphorus and magnesium is statistically lower compared to that of healthy children. This reveals the importance of children on gluten-free diets being given supplementary essential vitamins such as iron, zinc, magnesium and phosphorus, which play significant roles in various vital functions, such as body homeostasis and appropriate immune response.

Gluten-free diet is a form of treatment that applies for a lifetime that directly impacts the lives of patients. There are nutritional problems stemming – directly or indirectly – from long-term gluten-free nutrition. Overcoming or minimizing these is of great importance for patients' health. Bearing in mind these disease-associated nutritional risks, health teams should include a professional dietician trained in celiac disease to determine the patient's nutritional status, inform patients and regulate diet compliance and content.

Small sample size is one of the limitations of this study. Self reported dietary intake might also be biased. However this is valid for both groups.

Conclusions

1. During follow-up of celiac patients, dietary composition as well as compliance should be determined for better health outcomes. Dietary adequacy should be controlled in terms of macro- and micronutrients.

2. Health teams need to have a dietician specializing in monitoring children with celiac disease on gluten-free diets, and patients should be evaluated from that perspective at clinical check-ups.

3. In the light of different diet composition of children with celiac disease, long-term health effects of GFD in celiac patients should be investigated.

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