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ORIGINAL PAPER/*PRACA ORYGINALNA*

Is the taste, price and availability of gluten-free foods a deciding factor for adherence to a doctor-prescribed gluten-free diet?

Czy smak, cena i dostępność żywności bezglutenowej jest czynnikiem decydującym o przestrzeganiu przepisanej przez lekarza diety bezglutenowej?

Gabriela Harvanová, Silvia Duranková

Department of Biology, Faculty of Humanities and Natural Sciences, University of Prešov, Presov, Slovak Republic

ABSTRACT

Introduction: The number of people suffering from coeliac disease continues to grow and so does the global market for gluten-free food production. Currently, the availability of gluten-free foods is widespread, especially on websites, but people who do not have access to the internet, source these foods from local shops, supermarkets or pharmacies, where prices are several times more expensive, which has a significant impact on the economic and social status of the patient.

Aim: To determine patient satisfaction with the availability of gluten-free foods.

Material and methods: The research was conducted in eastern Slovakia by means of an anonymous questionnaire. Patients diagnosed with coeliac disease (150) completed the questionnaire during a preventive check-up at the gastroenterology outpatient clinic in Humenne.

Results: In our research, we investigated the association between improvement in the patient's health status and adherence to a gluten-free diet. At the same time, we were interested in whether patients who take a gluten-free diet suffer from anaemia and avitaminosis. Both assumptions were confirmed on the basis of statistical results.

Conclusions: Currently, the availability of these foods is convenient mainly because of internet offers. However, people who do not have access to the internet or are unable to order food are left to buy food from brick-and-mortar stores or pharmacies where these products are more expensive. A factor affecting adherence to the diet is the taste of the food, which has significantly decreased after gluten has been removed from the preparation formula, which may deter many patients from eating it.

KEY WORDS

malnutrition, gluten-free diet, gluten allergy, coeliac disease.

ADDRESS FOR CORRESPONDENCE

Silvia Duranková, Department of Biology, Faculty of Humanities and Natural Sciences, University of Prešov, Presov, Slovak Republic, e-mail: silvia.durankova@unipo.sk

INTRODUCTION

Coeliac disease is a chronic inflammatory disease of the small intestine which is caused by the intake of gluten into the digestive system of hypersensitive people [1, 2]. The disease is determined by genetic predisposition, but is also influenced by many environmental or socio-economic factors. Given the unusual nature of the manifestations, such as malnutrition or asymptomaticity in some patients, we can assume that coeliac disease is far more widespread than global statistics suggest [3]. Gluten ingestion in hypersensitive people causes enteropathy with mucosal surface damage resulting in abnormal nutrient absorption [4–6]. Gluten contains a combination of gliadin and glutenin. The importance of gluten lies mainly in food preparation. It acts as an emulsifier, making dough more elastic and easier to process. It is rubbery and elastic, forming a network filled with gas bubbles as it rises. The gluten makes the dough easier to process and some people find such baked goods more palatable. However, such products can be replaced with gluten-free or natural products that have never contained gluten – fruits, vegetables, eggs, meat, rice, corn, buckwheat and others [7, 8]. Experts recommend consuming naturally gluten-free products to avoid ingesting contaminated foods. Despite hygiene measures, some establishments are still not compartmentalised in the production of gluten-free and gluten-containing foods. Consequently, contamination can occur and gluten will also be present in gluten-free foods [7, 9, 10].

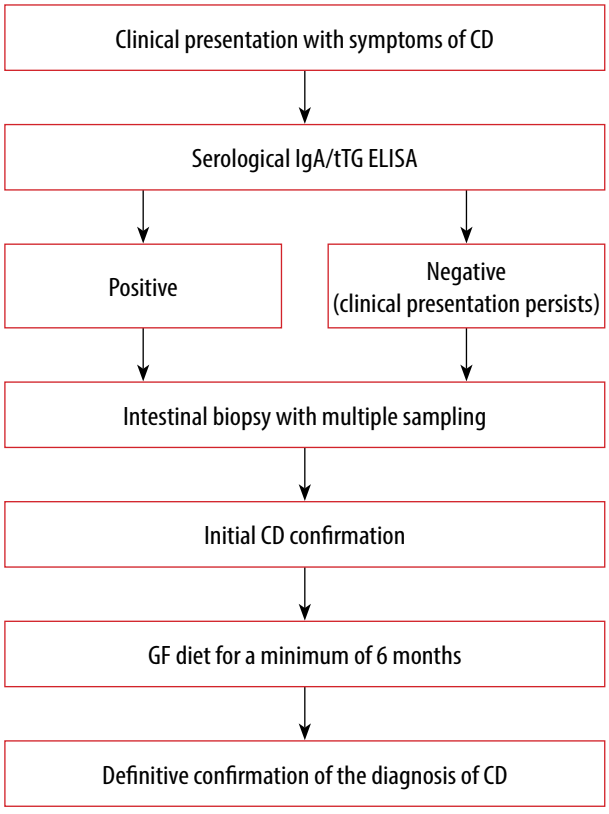

FIGURE 1. Diagnosis of patients with a clinical presentation resembling CD

Symptoms of coeliac disease are varied, including intestinal and extraintestinal symptoms – diarrhoea, abdominal pain, anaemia, osteoporosis, elevated liver enzymes, arthritis, and others [7, 11–14].

Before starting the diagnostic process, it is essential that the patient has a gluten-rich diet (about 4 slices of white bread per day or another alternative with approximately the same gluten content) for a period of at least 2, ideally up to 6 weeks. The diagnosis is then considered on the basis of samples taken from the small intestine and blood. In order for the doctor to confirm coeliac disease, both samples must be positive.

Histologically, the number of intraepithelial lymphocytes (IEL) located in the lamina propria is highly variable. Histological tissue samples taken from patients show the following features: decreased erythrocyte count, hyperplasia, villous atrophy, and increased intraepithelial T lymphocytes [3]. The number of γ/ δ cells and intraepithelial lymphocytes is markedly increased (> 40 IEL/ 100 epithelial cells), whereas in healthy individuals a number of 20 IEL/100 epithelial cells is counted [15].

Diagnosis by serological tests involves the evaluation of IgA antibodies to tissue transglutaminase in the blood by ELISA. The sensitivity of the antibodies is around 97% with an accuracy of 98% [16]. If serological tests are negative, but suspicion of coeliac disease persists, investigation by intestinal biopsy is indicated.

Intestinal biopsy represents the best method for diagnosis of coeliac disease, where various entities such as hyperplasia, villous arthropathy, inflammatory infiltrates, erythrocyte count from small bowel mucosal biopsy are evaluated according to Marsh criteria [17]. When evaluating a small bowel mucosal specimen, it is important to consider other diseases mimicking the clinical picture of coeliac disease. The diagnosis of coeliac disease should not depend only on the intestinal biopsy, but the clinical picture and the results of serological tests should also be taken into account [14] (Figure 1).

When a diagnosis of CD is confirmed, it is essential to exclude gluten-containing foods (wheat, rye, barley, oats) permanently from the diet. It is also necessary to exclude/restrict from the diet foods that could irritate the digestive system (coffee, black pepper, fatty foods, etc.). So far, a gluten-free diet is the only known type of treatment [18–23]. An individual approach to each patient is important as mucosal regeneration may progress faster in some patients and slower in others [11, 19]. A gluten-free diet can lead to nutrient deficiencies. Compared to foods containing gluten, gluten-free foods are deficient in minerals (calcium, iron, magnesium and zinc), similarly vitamins (B_{12}, D). As a result, it has been shown that a gluten-free diet may be more harmful to individuals who do not suffer from coeliac disease than a conventional diet [24]. Gluten-free foods contain more fat, sugar and sodium, and this composition can vary depending on the type of products. Studies have shown that the fat content of gluten-free bread is almost twice that of regular gluten-containing bread. There is an increased carbohydrate and sodium threshold in gluten-free pasta compared to conventional pasta [25, 26]. Many studies have shown that 20.00–38.00% of patients on a gluten-free diet suffer from nutrient intake complications such as protein imbalances, deficiencies in minerals, vitamins and other body-beneficial substances. All of these complications are a result of non-absorption of nutrients due to damage to the lining of the intestine. From an anthropometric point of view, a gluten-free diet can help in fat reduction, restoration of muscle mass and normalization of BMI [27]. However, establishing a proper diet is very important. As confirmed by Dickey and Kearney in their study, a gluten-free diet needs to be adjusted to avoid weight loss or gain [28].

From an economic point of view, it is not always easy to follow the diet prescribed by a gastroenterologist. Despite the wide range of products available in online stores, buying them is significantly more expensive than buying wheat-based foods. Given the predominantly internet-based availability, patients with older age or lack of computer literacy are reliant on local businesses selling gluten-free foods. Gluten-free food is not only available in supermarkets or retail outlets but also in pharmacies, but with a significant difference in the price of the food.

Despite the financial benefits provided by health insurance companies, buying such food is difficult for a middle-class person. The General Health Insurance Fund provides a financial allowance of €200 per year for dietary foods for coeliacs [29]. The insurer Dôvera provides its policyholders with a 25.00% discount on the purchase of gluten-free products, only on its special website [30]. The insurance company Union provides reimbursement of additional payments for medicines and dietetic food for children up to 18 years of age. However, this offer only applies to foods and medicines on the categorisation list of dietetic foods and medicines for which the patient is paying a supplement. Over-the-counter drugs, devices or dietetic products are not covered by this benefit [31].

As the diet for coeliac patients does not contain gluten, the texture and taste of the food will be fundamentally altered. The loss of elasticity, elasticity or change in texture also results in a reduction in the pleasant taste of the food [32].

MATERIAL AND METHODS

The main aim of the research was to determine the availability of gluten-free foods for patients in eastern Slovakia, given more lower availability of gluten-free foods and the economic situation in the country. The research was conducted in the territory of eastern Slovakia by means of an anonymous questionnaire. The questionnaire was completed by patients diagnosed with gluten enteropathy during a preventive examination in the gastroenterology outpatient clinic in Humenne. The study sample consisted of 150 patients (139 women and 11 men) aged 20 to 67 years. The patients followed a diet depending on their health status, prescribed by a gastroenterologist, for 2–6 years. Subsequently, the results were statistically processed using GraphPad Prism 5 software, namely Dunn's multiple comparison test, and presented in tables. The next step was to make a table with a price overview of basic gluten-free and gluten-containing foods.

RESULTS

In our research, we focused on several important points:

1) an informative overview of the gluten-free diet situation (adherence, cost, taste and availability of gluten-free foods, use of probiotics, etc.),
2) the existence of a correlation between the improvement of the patient's health status and adherence to a doctor-prescribed gluten-free diet,
3) the effect of a gluten-free diet on erythrocyte production (diagnosed anemia) and vitamin deficiency (avitaminosis),
4) an overview table with the affordability of different types of food (Table 1).

Information Table 1 informed us about the overall situation of patients with coeliac disease in eastern Slovakia. We focused on the associations between adherence to a gluten-free diet and patient health, and gluten-free diet and diagnosis of anaemia and avitaminosis. We then statistically evaluated these parameters (Tables 2, 3). Both showed highly significant statistical significance. We then

TABLE 1. Overview of the results of the questionnaire survey

Questions	Answers	Women, *n* (%)	Men, *n* (%)
Q1: Are you familiar with the term "coeliac disease" and the function of gluten in the body?	Yes No	139 (100.00) 0 (0.00)	11 (100.00) 0 (0.00)
Q2: Do you follow the diet prescribed by your doctor?	Yes No	131 (94.24) 8 (5.76)	10 (90.90) 1 (9.09)
Q3: Approximately how much has your health improved during the diet from before the diet? (please specify)	0-25 26-50 51-75 76-100	28 (20.14) 29 (20.86) 21 (15.11) 61 (43.88)	2 (18.18) 3 (27.27) 0 (0.00) 6 (54.55)
Q4: Have you been diagnosed with any other conditions related to coeliac disease?	Osteoporosis Anaemia Avitaminosis No Other (please specify)	15 (10.79) 31 (22.30) 12 (8.63) 10 (7.19) 71 (51.08)	3 (27.27) 1 (9.09) 1 (9.09) 3 (27.27) 3 (27.27)
Q5: What is the biggest disadvantage of buying gluten-free foods?	Price Availability Taste of the products Other (please specify)	30 (21.58) 7 (5.04) 8 (5.76) 94 (67.62)	2 (18.18) 0 (0.00) 0 (0.00) 9 (81.82)
Q6: How satisfied are you with your choice of gluten-free foods?	Very satisfied Satisfied Not very satisfied Very dissatisfied	15 (10.79) 90 (64.75) 26 (18.71) 8 (5.76)	0 (0.00) 7 (63.63) 3 (27.27) 1 (9.09)
Q7: Do you take any probiotics (e.g. Lactobacillus, Bifidobacterium) as prevention? If so, have you noticed any changes in your body because of them?	Yes No Other (please specify)	40 (28.78) 94 (67.62) 5 (3.60)	3 (27.27) 8 (72.72) 0 (0.00)

tabulated the prices of gluten-free versus gluten-containing foods. We found that consuming gluten-free foods is once as expensive as consuming foods that do not require a gluten-free diet (Figure 2).

TABLE 2. Statistical association between adherence to a gluten-free diet and patient health status

Dunn's Multiple Comparison Test	Difference in rank sum	$P < 0.05$
Diet vs. health status	–95.00	Yes***
Diet vs. sex	–6.267	No^{ns}
Health status vs. sex	88.73	Yes***

TABLE 3. Statistical association between adherence to a gluten-free diet and diagnosis of anaemia and avitaminosis

Dunn's Multiple Comparison Test	Difference in rank sum	$P < 0.05$
Diet vs. anaemia, avitaminosis	–42.14	Yes***
Diet vs. sex	–1.357	No^{ns}
Anaemia, avitaminosis vs. sex	40.79	Yes***

DISCUSSION

Coeliac disease is a lifelong inflammatory disease of the small intestine where the only known treatment so far is to follow a gluten-free diet. It is essential to inform the general public about the correct treatment and adherence to it. Several studies suggest that it is patients' lack of

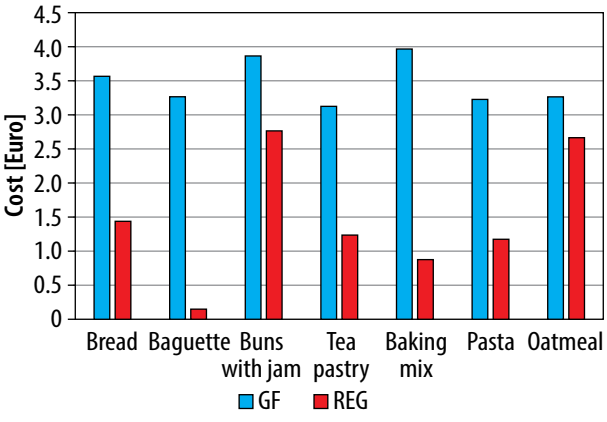

FIGURE 2. Price comparison of gluten-free (GF) and wheat-containing (regular, REG) foods

awareness that results in non-adherence to a gluten-free diet, leading to further health complications.

Our survey focused on whether the availability, price or taste of a gluten-free diet can influence adherence and thus improve patient health. From the survey, we found that 9.00% of respondents do not adhere to this diet. This may be related to the finding that the health status of up to 30.00% of the total respondents did not improve or only a slight improvement was noted. One possible explanation may be that the gluten-free diet was followed for a short period of time or gluten-containing foods were consumed together with the gluten-free diet, i.e. the mucosa of the small intestine did not have time to recover [7, 33].

The economic situation of the patient is another factor in treatment adherence. A study conducted by Lee *et al.* examined the availability and cost of gluten-free foods compared to wheat equivalents. Their research shows that gluten-free foods are not sufficiently available and are demonstrably more expensive than wheat-based foods, which may result in a lack of economic resources for the patient to purchase and therefore adhere to a gluten-free diet [34]. There is, however, the possibility of a financial contribution from the social security, but this will only cover a very small amount of the cost of gluten-free food. In research by Panagiotou and Kontogianni, gluten-free foods have been shown to increase in price by 22–334% in supermarkets and 88–476% in pharmacies compared to wheat foods [35]. In our research, 21.58% of women and 18.18% of men said that price is one of the disadvantages when buying gluten-free foods. Among other criteria, patients specified price and taste at the same time. In a study by Alencar *et al.*, patients reported that they missed the taste (32.00%) and texture (30.00%) of conventional wheat foods the most on a gluten-free diet [36]. Another criterion that hindered the respondents was the price (19.00%) of the food and its variety and availability (15.00%) [37]. Also, some are not satisfied with the availability of gluten-free products, but 64.75% of women and 63.63% of men are satisfied with the offer of gluten-free foods.

In comparison, 67.00% of the respondents' health improved, almost to the original state as it was before the disease. We compared these results with research conducted by Niland and Cash, and they similarly showed an improvement in patients' health status after following a gluten-free diet [37, 38].

Due to various deficiencies in the production of gluten-free foods (lack of fibre, minerals, vitamins), there is a high likelihood of other co-morbidities [39]. As expected, the most common comorbidity was anaemia (32.00%) as the body was unable to absorb sufficient nutrients [40–43]. A further 18.00% of respondents identified osteoporosis as a co-morbidity [44, 45]. According to Gujral *et al.*, co-morbidities occur in about 50.00% of patients from a worldwide survey [46].

Since coeliac disease is an inflammatory disease, many doctors recommend taking pro-inflammatory drugs along with a gluten-free diet. Research conducted in animal models indicates that probiotics modulate the immune response, which can reduce gliadin-induced inflammation [47–50]. The vast majority of our respondents (67.62% of females and 72.72% of males) do not take probiotics, which may correlate closely with the slow recovery of small intestinal mucosal microcracks. With gluten enteropathy as a lifelong inflammatory disease, it is necessary to be familiar with all areas of possible prevention of difficulties and treatment, which includes a gluten-free diet recommended by a gastroenterologist and set by a dietician and its adherence. Price, taste and availability play a significant role in this disease so there is a need for more in-depth research into this issue and to resolve issues relating to improving the taste and texture of foods, availability and, most importantly, their price.

CONCLUSIONS

A gluten-free diet has been the only treatment for coeliac disease so far. Its strict adherence can improve the patient's life compared to the pre-disease state. However, many patients either do not follow the diet at all or include gluten-containing foods in their diet, precisely because of lack of awareness, lack of availability or the price of these foods. It is essential to understand that improvement in health is directly proportional to adherence to a gluten-free diet. From an economic point of view, some types of gluten-free food are five times more expensive than their wheat equivalents, which in many cases makes it impossible for the patient to buy them. Thanks to the internet, ordering gluten-free food is a huge advantage, but people who do not have access to the internet or cannot order food are left to buy food in brick-and-mortar shops, pharmacies or supermarkets where the products are more expensive. The main factors affecting adherence to the diet are the taste of the food (which has been significantly reduced after gluten has been removed from the recipe, which may deter many patients from eating it) and the price (the increase in price of the products compared to conventional wheat-based foods). The aim of this study was to determine patient satisfaction with the availability and price of gluten-free foods in light of the economic situation in the country. We also wanted to highlight this alarming problem of patients having to pay large sums of money out of their limited incomes for the treatment of their disease. Given the results of our research, we can conclude that the price, availability and

taste of gluten-free foods are major factors in adherence to a prescribed diet.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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