Coeliac disease: an overview

Christina R Sadler*, Stefan Storcksdieck genannt Bonsmann, Mary Friel
*Corresponding author
European Food Information Council (EUFIC), Tassel House,
rue Paul-Emile Janson 6, B-1000 Brussels, Belgium

Christina R. Sadler

KEYWORDS: coeliac; autoimmune; gluten; labelling; prevalence; diagnosis

ABSTRACT: Coeliac disease is an autoimmune disorder which can develop at any time throughout life. In susceptible individuals, eating gluten, a protein in wheat and related grains, causes damage to the small intestine. Currently, testing for coeliac disease is recommended for individuals at high-risk or presenting symptoms; however it is underdiagnosed due to the diverse clinical presentation. Following a gluten-free diet is currently the only effective treatment. The prescribed gluten-free diet should be monitored, with dietary assessment and support from a trained dietitian. Food labelling helps people with coeliac disease identify 'gluten free' or 'very low gluten' foods. Research is exploring alternative treatments, and whether the timing and amount of gluten consumed during infancy can be altered for the prevention of coeliac disease.

COELIAC DISEASE AND OTHER ADVERSE REACTIONS TO FOOD

For a small percentage of people, specific foods or components of food may cause non-toxic adverse reactions, typically classified as food allergy (immune-mediated) or food intolerance (non immune-mediated) (1).
A food allergy occurs when an allergen (usually a protein in the offending food, which in the majority of people will not produce an adverse reaction) sets off a chain of reproducible reactions involving the immune system. Allergic reactions can be classified based on the mechanisms involved, i.e. they can be either IgE (immunoglobulin E antibodies) or non-IgE mediated reactions. The former are usually immediate; whereas, the latter are usually more delayed (1).
Food intolerances do not involve the immune system. Food intolerant reactions may be categorised as enzymatic (due to an enzyme deficiency such as lactase which is needed to digest lactose in milk), pharmacological (due to vasoactive amines, e.g. histamine, which may produce pharmacological effects in intolerant patients) or undefined (intolerance resulting from non-identified mechanisms). Some food aversions may mimic allergy or food intolerance, but in fact may be caused by psychological factors (1).
Regarding gluten-related disorders, a group of experts convened in 2011 and discussed current evidence to agree and propose new nomenclature and classification (2). This nomenclature is presented in Figure 1 and is discussed below.
Wheat allergy is an example of an IgE -mediated reaction. It can occur minutes to hours after wheat consumption, and may affect the skin, gastrointestinal tract or respiratory tract (2).
Coeliac disease is neither an allergy nor a simple food intolerance but rather an autoimmune disease. Today's accepted definition is an 'immune mediated systemic disorder elicited by gluten and related prolamines in genetically susceptible individuals' (3). Gluten is found in wheat, rye, barley, oats or their crossbred varieties and derivatives thereof. The specific proteins are gliadins in wheat, secalins in rye, hordeins in barley, and a similar protein, avenin, is found in oats. When people with coeliac disease eat gluten, the body produces antibodies which attack the lining of the small intestine and other areas of the body (4). The onset of symptoms is usually gradual and can arise months or years after gluten introduction. Ingestion of gluten can occasionally cause immediate symptoms in people with coeliac disease on long-term treatment (2). Continued consumption of gluten increases the risk of i) inflammation in the intestine, ii) nutrient deficiencies, and iii) consequential conditions including anaemia, osteoporosis and infertility (particularly in females) (4, 5).
Recently, clinicians have begun to recognise another form of gluten-induced disorder, non-coeliac gluten sensitivity (or gluten intolerance), which is neither an autoimmune nor an allergic response. While this condition is currently poorly understood, it is of great research interest (6).

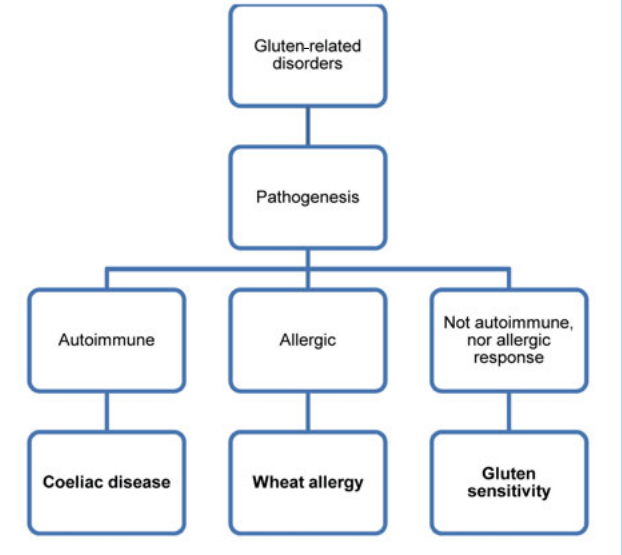

Figure 1. Proposed new nomenclature and classification of gluten-related disorders (adapted from (2)).

Prevalence and diagnosis

Coeliac disease can develop at any time throughout life, as a result of interplay between genetic, immunological and environmental factors. In Europe, an estimated 1% of adults and children have coeliac disease, which makes it one of the most common chronic disorders (7). The prevalence of coeliac disease varies widely between countries. A large study, using a subsample of people aged 30-64 years, found that it is

eight times higher in Finland (2.4%) than in Germany (0.3%). In Finland, the prevalence has doubled over 20 years, which cannot be explained by better detection rates alone, and rather suggests a true rise in prevalence (8).

Coeliac disease is highly under-diagnosed, which heightens the risk of long-term complications. Diagnosis is impeded by the diverse and ambiguous clinical presentation. Symptoms vary from person to person and from mild to severe. They can be non-specific (*e.g.* tiredness, headaches), and bowel symptoms (abdominal pain, bloating, diarrhoea) are similar to irritable bowel syndrome and other gut conditions. Symptoms can be absent despite intestinal damage ('silent' coeliac disease) (6, 7). Furthermore, there is a lack of understanding of the natural course of the disease, including how risk of complications varies between individuals (6). Under-diagnosis is perhaps perpetuated by the misconception that coeliac patients are underweight, whereas in fact many are normal weight or overweight (9).

Diagnosis of coeliac disease is made by blood tests for high levels of coeliac disease-specific antibodies (serological testing), and confirmed by examination of changes in the gut using small-bowel biopsy (3, 10). Further blood tests include genotyping to identify human leukocyte antigens (HLA DQ2 and DQ8) which are associated with coeliac disease. Updated guidelines on diagnosis in children, from the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN), conclude that a combination testing positive for symptoms, antibodies and HLA together may obviate the need for a biopsy (3). Serological tests for coeliac disease have high levels of sensitivity and specificity. However, a false negative result can occur due to IgA deficiency, if IgA-based antibody tests are used. Furthermore, the accuracy of the diagnostic tests relies on the consumption of a gluten-containing diet (3, 10). The individual should continue to eat gluten-containing foods before testing and until diagnosis is confirmed. Currently, testing is recommended for symptomatic individuals (including the wide variety of presentations and associated conditions such as osteoporosis or iron-deficiency anaemia), and those with increased risk of coeliac disease including people with existing autoimmune disease (*e.g.*, type 1 diabetes, autoimmune thyroid disease) and people with first-degree relatives with coeliac disease (3, 10). Although mass screening for coeliac disease would diagnose many undetected cases, there is not enough evidence to support its implementation (11). This includes the clinical complexities previously described (6).

The prevalence and diagnosis of 'non-coeliac gluten sensitivity' is not yet established. Research is needed to develop biomarkers which could be used for blood tests (6). A group of experts has recommended first ruling out a diagnosis of coeliac disease or wheat allergy. In a second step, sensitivity to gluten should be identified using a 'double-placebo gluten challenge'. The person would eliminate gluten from their diet, and then be monitored when 'challenged' by reintroduction of gluten-containing foods. This test should be double-blind; neither the challenged person nor the supervising physician should know which patient receives a gluten-containing diet (2). However, there are practical difficulties conducting the double-placebo gluten challenge. Further research is needed to determine the possibility of a placebo effect. A control trial is underway and due for completion in September 2013 (12).

THE CHALLENGE OF A GLUTEN-FREE DIET

A strict, lifelong gluten-free (GF) diet allows the small intestine to recover. Obvious sources of gluten are bread, many breakfast cereals, pasta, pizza, cakes and biscuits. Gluten may also be used to give structure to food products such as sausages, stock cubes, soups and sauces. Traditional beers are produced using varying quantities of barley malt, and are therefore not suitable for people with coeliac disease. Natural GF foods include fresh meat, fish, eggs, fruit, vegetables, dairy products, beans, potatoes, rice, maize, quinoa and buckwheat. Substitute foods such as specially-made GF bread, flour, pasta, crackers, and baking aids which improve texture (such as xanthan gum) have increased in variety in recent years and are available on prescription in some countries (3, 5).

On diagnosis, people with coeliac disease should be assessed for any nutritional deficiencies and receive professional dietary counselling and regular follow-up. Improvement should, in general, be achieved within 12 months of adopting a GF diet (3). If symptoms persist while on a GF diet, further medical investigation may be required as these may be due to another condition. However, continued gluten consumption is the likely cause (3, 6). People with coeliac disease vary in their sensitivity to very small residual amounts of gluten (13).

There has been confusion about whether oats can be included in a GF diet. Oats are often grown on land used for other cereals that contain gluten and may also come into contact with gluten-containing cereals at subsequent stages of processing, such as during milling. Pure uncontaminated oats, labelled 'gluten-free', are considered safe for most. However, a small proportion of people may (also) have an immune response to the oat protein avenin. Those newly diagnosed with coeliac disease should avoid oats until the disease is well controlled by a GF diet, when GF oats can be gradually introduced whilst monitoring for adverse effects (14).

Every effort must be taken to avoid cross-contamination between GF foods and foods containing gluten. GF foods should be prepared away from gluten-containing foods. Surfaces should be washed down. Clean or separate utensils should be used, including breadboards, and toasters or toaster-bags. Condiments (such as butter and jam) should be kept in separate containers or always served with clean utensils. When frying GF foods, clean oil which has not been used to fry gluten-containing foods should be used (4).

Inadvertent gluten consumption may occur due to

misconceptions about gluten-containing foods or by cross-contamination, which highlights the importance of education and support. Support is available from both qualified dietitians and official coeliac societies across Europe (5). Qualified dietitians knowledgeable about managing a GF diet can help educate and ensure that the diet is balanced and contains the right amount of energy, dietary fibre and micronutrients. Adults with coeliac disease have a higher requirement for calcium, and are advised to consume 1500 mg calcium daily, due to their increased risk of osteoporosis (15).

A review of the literature found that across studies, levels of strict adherence to a GF diet ranged from 42% to 91% of patients, depending on the definition and assessment (16). It has also been reported that adherence is influenced by cognitive, emotional and socio-cultural factors (such as beliefs about the harmful effects of gluten, and feelings of anger or embarrassment), membership of an advocacy group and regular dietetic follow-up (16). Further studies suggest psychological factors (depression, anxiety, coping in stressful situations, eating disorders) may stop people fulfilling their intention to adhere to a GF diet, and recommends that interventions should include 'behaviour change' techniques to develop coping skills (17).

Figure 2. Crossed Grain trademark symbol which may be used under licence by companies and organisations to label gluten-free food and drink products which meet the eligibility criteria (4, 5)
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FOOD LABELLING

If a gluten-containing ingredient is used in the production of a foodstuff, then the gluten source (i.e. the specific grain that has been used, for example, wheat, rye, barley, oats, spelt, kamut or their hybridised strains) must be on the label (18).

There are a number of exemptions from the labelling requirement for ingredients or substances derived from gluten. These apply to substances for which it has been scientifically established that they are not likely, under specific circumstances, to trigger adverse reactions. These include ingredients derived from gluten-containing cereals for which the gluten is removed during processing (e.g. glucose syrups including dextrose, wheat-based maltodextrins, distilled ingredients such as alcoholic spirits) (18).

Since January 2012, legislation has defined criteria for marketing of products suitable for people with coeliac disease (13). Foods labelled 'gluten-free' must not contain more than 20 mg of gluten per 1 kg. This low concentration of gluten offers a high degree of consumer protection to those with coeliac disease (19). Specialist products containing between 20 and 100 mg of gluten per 1 kg can be labelled 'very low gluten', suitable for most people with coeliac disease except those who are particularly sensitive (13).

The legislation also allows for a normal food which does not contain ingredients derived from gluten-containing grains or oats to be labelled using terms indicating the absence of gluten. However, such a statement must not mislead the consumer by suggesting that the food possesses special characteristics, when in fact, all similar foodstuffs possess such characteristics. Manufacturers and retailers may also choose to label their GF products with the Crossed Grain trademark symbol (Figure 2). This symbol can only be used under licence by companies and organisations on food and drink products which meet specific criteria. This symbol is recognised worldwide by people with coeliac disease and helps in the identification of GF products (4, 5).

New labelling rules coming into force in late 2014, will require gluten-containing cereals to be highlighted on the list of ingredients, e.g. by font, style or colour. It should be noted that if the food product is not required to have a list of ingredients, e.g. alcohol, then the label must either refer to the particular ingredient in the name of the product, e.g. wheat beer, or the label must state "contains", followed by the gluten source, e.g. "contains wheat" (20). In addition, the requirement to provide information about gluten-containing cereals will be extended to non-pre-packed food, i.e. foods sold loose in retail, catering establishments etc. The exact requirements are to be established in national law (20). This will be difficult to implement in practice, e.g. due to variable and flexible menus in restaurants, from food caterers, market stalls and supermarket deli counters. A recent audit of 12 catering establishments in Ireland recommended that 'catering businesses should educate their staff on food allergens and the new legal requirements while considering how best to comply with new allergen labelling requirements' (21).

FUTURE

Since a strict life-long GF diet can be challenging, current research is also exploring future strategies for an alternative or adjunctive treatments. These include the production of modified wheat strains to remove the immunogenic effect of gluten but retain its baking properties (e.g. by genetic modification), oral drug therapy (targeting different processes involved in the immune reaction to gluten e.g. to break down gluten in the gastrointestinal tract, prevent its absorption, inhibit the immune response) and vaccination (22). These approaches are under development and some are in clinical trials. Further research is needed to ensure that these novel treatments would be as safe and effective as a GF diet.

Additionally, more research is needed to define how genetic and environmental factors may be responsible (7, 8). For example, factors which may help prevent or delay coeliac disease such as breastfeeding, timing of gluten introduction and amount of gluten in an infant's diet, are currently being explored in more detail by an international research project called Prevent Coeliac Disease (PREVENTCD) (23). Results of the study are expected in mid-2013, by which time all participants of the study will be three years of age, and they will continue to be followed until ten years of age. In the meantime, it is advised to follow current recommendations made by scientific organisations (24). ESPGHAN recommendations from 2008 promote exclusive or full breastfeeding for about 6 months. Complementary feeding (solid foods/liquids other than breast milk or infant formula) should not be introduced in any infant before 17 weeks, and all infants should start complementary feeding by 26 weeks. ESPGHAN recommends to avoid both early (before 4 months of age) and late (after 7 months of age) introduction of gluten, and to introduce gluten gradually whilst the infant is still being breastfed (25).

CONCLUSIONS

Coeliac disease is common in Europe. A GF diet can ameliorate symptoms, prevent long-term complications, and it remains the only safe treatment. Accurate medical diagnosis is important and necessary before making dietary changes. Varying and non-specific symptoms can mean the disease goes undetected. There needs to be an awareness of the wide clinical presentation of the disease, and how people can be supported to follow a prescribed GF diet (including how to avoid cross-contamination in food preparation).

Further research will explore the nature of gluten-related disorders. This may improve diagnosis, treatment (dietary or other), and also work towards prevention of coeliac disease. There is also a need to establish the diagnosis and management of 'non-coeliac gluten sensitivity' (gluten intolerance), for people who do not have coeliac disease but may benefit from a GF diet.

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