The Gluten-Free Diet: Fad or Necessity?

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The gluten-free diet, touted by celebrities for weight loss (1) and athletes for improved performance (2), is virtually impossible to avoid hearing about. Between 2004 and 2011, the market for gluten-free products grew at an annual rate of 28% (3), with an estimated $2.6 billion in sales in 2012 (4) that is expected to reach $6.6 billion by 2017 (5). A 2013 survey from NPD (formerly National Purchase Diary, a market research group) found that 30% of Americans showed interest in avoiding gluten (6). Also in 2013, the U.S. Food and Drug Administration (FDA) issued the final rule on gluten-free food labeling, effective in August 2014 (7), making the gluten-free label a more common sight in the grocery store.

Although the gluten-free diet is an absolute necessity for people with celiac disease or nonceliac gluten sensitivity (NCGS), people without diagnosed gluten issues are trying the diet to assist in the management of other medical issues. A 2013 study found that 65% of American adults think gluten-free foods are healthier, and 27% choose gluten-free products to aid in weight loss (8).

There is a well-established relationship between type 1 diabetes and celiac disease. But for those with diabetes who have not been diagnosed with either celiac disease or NCGS, is there a benefit to going gluten-free? Are there risks to eating gluten-free without a diagnosis of celiac disease or NCGS? What special challenges exist for those with concurrent diabetes and celiac disease or NCGS? And finally, how can patients improve the nutritional profile of the gluten-free diet in terms of fiber, iron, calcium, and vitamin D to address deficiencies created by celiac disease or by the gluten-free diet?

Celiac Disease Defined

Celiac disease is an inherited autoimmune condition that affects ~1% of the population, although for every case diagnosed, it is thought that 5–10 cases remain undiagnosed (9). The consumption of gluten from wheat and related prolamins from barley and rye causes damage to the villi of the small intestine. This damage results in malabsorption of nutrients (10). Adult patients may present with gastrointestinal complaints such as abdominal pain, diarrhea, unintentional weight loss, and constipation. They may also present with extra-intestinal symptoms such as iron deficiency anemia, reduced bone density or osteoporosis, infertility, miscarriage, skin rash (dermatitis herpetiformis), depression, elevated liver enzymes, neuropathy, and headaches (11). Pediatric patients may present with unexplained growth failure or failure to thrive, short stature, diarrhea, delayed puberty, and iron deficiency anemia (12).

Diagnosis: Not Putting the Cart Before the Horse

Serology studies are the first step in determining diagnosis, specifically the serum immunoglobulin A (IgA)

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TABLE 1. FDA Rule for Gluten-Free Food Labeling (7)

The FDA labeling rule for gluten-free foods states that a food may be labeled gluten free if the following criteria are met:

1. It **is** a naturally gluten-free food (e.g., fruit or bottled water)
2. It is **not** made from a gluten-containing grain (e.g., barley or wheat)
3. It is **not** derived from a gluten-containing grain that has not been processed to remove gluten (e.g., wheat flour)
4. It **may** include a gluten-containing grain that has been processed to remove gluten (the example FDA provides is wheat starch) **as long as the final product has <20 ppm of gluten**

Other important points to note:

- The gluten-free labeling rule covers both ingredients and cross contact (during manufacturing or packaging) with gluten; the **final product**—not just the ingredients—must contain <20 ppm of gluten
- Terms such as "free of gluten," "without gluten," and "no gluten" may be used interchangeably with "gluten-free" but also must meet the standard of <20 ppm of gluten. Terms such as "no gluten ingredients" or "not made with gluten-containing ingredients" do not have to meet the standard and may not be gluten-free.
- Allergen advisory statements such as "made in a shared facility with wheat" are acceptable on gluten-free products, as long as the final product meets the <20 ppm standard; note that such advisory statements are voluntary and do not imply that the product is or is not safe

TABLE 2. Strategies for Increasing Fiber Intake on the Gluten-Free Diet

Practical strategies for increasing fiber on the gluten-free diet include:

- Use gluten-free whole grains* whenever possible instead of white rice; examples include quinoa, amaranth, teff, millet, sorghum, brown or wild rice, buckwheat, and gluten-free oats
- Incorporate cooked legumes into mixed dishes or as side dishes
- Instead of potato chips, try crunchy vegetables as sides for sandwiches and wraps
- Select a whole-grain gluten-free breakfast cereal instead of a rice-based cereal
- Use a slow cooker to make hot breakfast cereals such as gluten-free quinoa or gluten-free oats
- Add vegetables and brown rice to gluten-free wraps
- Select gluten-free whole-grain crackers instead of rice-based crackers
- Select gluten-free whole grain pasta (e.g., quinoa-based pasta) in place of corn or rice pasta
- Select popcorn or gluten-free trail mix for a snack

**Grain products should always be labeled "gluten-free."*

anti-tissue transglutaminase (TTG) antibodies. Patients should also be screened for total IgA because this affects the reliability of the TTG test (13). These are accurate and inexpensive tests; however, it is very important to note that patients must be on a gluten-containing diet at the time of testing to avoid false negative results. This has become more of a problem in clinical practice because patients may present to their health care provider after several months or even years on the gluten-free diet. This can lead to a diagnostic conundrum for the provider and patient. To obtain accurate antibody results, patients must complete a "gluten challenge," in which they consume a specified amount of gluten-containing foods for several weeks (14). For patients who have obtained symptom relief with the gluten-free diet, returning to a gluten-containing diet may be undesirable. This can leave such patients without a clear diagnosis.

Genetic tests can be helpful in those who are already following the gluten-free diet; however, these tests cannot diagnose celiac disease on their own. About 40% of the general population carry the genes responsible for celiac disease, but most never develop the disease (12). Additionally, individuals with type 1 diabetes can have temporary elevations in the antibodies for celiac disease (15). For this reason, it is important to confirm serology with a small bowel biopsy, particularly in those with type 1 diabetes who may not show typical celiac disease symptoms (15).

Type 1 Diabetes and Celiac Disease

The prevalence of celiac disease is increased in those with other autoimmune diseases, including type 1 diabetes. The prevalence of celiac disease in people with type 1 diabetes is estimated to be between 1.4 and 19.7% (16). The common denominators in both conditions are the *HLA DQ2* and *HLA DQ8* genes (17); however, environmental factors such as infections, infant feeding practices, and breastfeeding may play a role, although to what extent is unknown (18). In addition, there is emerging research into the potential role of the gut microbiome (18).

In children, a diagnosis of type 1 diabetes typically precedes the diagnosis of celiac disease, and the celiac disease diagnosis most often occurs within 5 years of the diabetes diagnosis (16). Children with type 1 diabetes may not present with typical gastrointestinal celiac disease symptoms, but rather may still show growth failure and delay in puberty (18). A typical gastrointestinal presentation in those with type 1 diabetes is actually the exception, occurring in <10% of patients. More often, people with type 1 diabetes and celiac disease are asymptomatic or present with only mild symptoms (17). For this reason, patients with type 1 diabetes should be screened for celiac disease at the time of diabetes diagnosis (12). The timeline for follow-up screening for celiac disease remains controversial, but all agree that those with type 1 diabetes should be screened at regular intervals, either annually or biannually (19,20). Mass screening of the general population for celiac disease is not currently recommended (21).

Adult patients with new onset type 1 diabetes may be even more likely to develop celiac disease. Bakker et al. (19) found that 42% of those with adult-onset type 1 diabetes developed celiac disease 10 years after diagnosis. A delay in celiac disease diagnosis may occur in adults, whose gastrointestinal symptoms may be incorrectly attributed to neuropathy (22). One study found that 48% of adult patients with type 1 diabetes had been symptomatic for >5 years before being diagnosed with celiac disease (23).

There does not appear to be a link between type 2 diabetes, metabolic syndrome, and the development of celiac disease. One study showed a lower incidence of type 2 diabetes and metabolic syndrome in those with celiac disease, even after controlling for BMI, which was significantly lower in those with celiac disease (24).

Some smaller studies suggest that patients with both type 1 diabetes and celiac disease may derive benefit in the prevention of some diabetes complications by adopting the gluten-free diet, although the research remains conflicted. For example, one study found a lower risk of retinopathy for those with diagnosed celiac disease (19), whereas another found an increased risk of retinopathy (25). Picarelli et al. (26) found that those with type 1 diabetes and celiac disease may have reduced cholesterol levels, lower A1C values, and lower rates of retinopathy and nephropathy.

Possible Risks of Eating Gluten-Free in the Absence of Celiac Disease

A 2015 study that reviewed records of patients presenting for evaluation in celiac disease clinics found that 11% had at some point avoided gluten without a diagnosis of celiac disease. Reasons given for adopting the gluten-free diet included lactose intolerance and irritable bowel syndrome (27). A 2012 study of 579 children and adolescents found that 7.4% were avoiding gluten without a celiac disease diagnosis. The study found that the strongest predictors of participants following the gluten-free diet included irritability, family history of celiac disease, bowel movement changes, diarrhea, and autism (28).

Some evidence indicates that there are significant drawbacks to following the gluten-free diet. For example, gluten-free processed grain products (e.g., breads, cereals, and crackers) are often lower in fiber, iron, zinc, and potassium (29). The gluten-free diet also may increase the risks for nutritional deficiencies, especially in B vitamins, iron, and trace minerals (30). In addition, gluten-free products continue to be significantly more expensive. A 2015 study found that gluten-free bread and bakery products were on average 267% more expensive than gluten-containing breads, and gluten-free cereals were found to be 205% more expensive than gluten-containing cereals (29).

Individuals following the gluten-free diet also may fail to adhere to recommendations regarding daily servings of grain products. One study found that 38% of patients with celiac disease included no grain or starch choice at meals; when patients did choose a grain product, 44% most frequently chose rice (31). In another survey of people with celiac disease, 80% were eating less than half of the recommended daily amount of grains, and only 1.1% ate the six recommended servings each day. Of those who did eat grain products, 61% most frequently chose rice and corn (32).

Weighty Matters

Although the gluten-free diet has been purported to aid in weight loss (3), for those with celiac disease, it may actually cause weight gain. For some, this can be desirable, particularly if weight loss was a symptom preceding diagnosis. But for others, the gluten-free diet may exacerbate existing overweight or obesity. In a study of adults with celiac disease, weight gain occurred in 27% of already overweight or obese patients (33). This effect was also found in children; a study of children on the gluten-free diet for at least 1 year found that the proportion of overweight children rose from 11 to 21% (34).

The reasons for weight gain in those with celiac disease include improved absorption of nutrients and improvement in abdominal symptoms. Gluten-free foods often are higher in fat and calories than their gluten-containing counterparts while also being lower in fiber and whole grains (3). A 2010 study showed that women on the gluten-free diet consumed significantly more carbohydrates, protein, and fat compared to control subjects, and men consumed more carbohydrates and fat. Both groups showed a lower intake of dietary fiber (35). There are no published studies on the benefits of the gluten-free diet on the weight status of those without celiac disease (3).

The Gluten-Free Diet for Life

Currently, following the gluten-free diet for life is the only treatment for celiac disease, although medications may become available in the future (36). The gluten-free diet involves the complete avoidance of wheat, rye, barley, and regular oats. Specialty gluten-free oats are tolerated by the majority of people with celiac disease (37). In addition, those following the gluten-free diet must take special care to avoid gluten contamination of food in their home kitchens, restaurants, and workplaces. Obvious foods to avoid include regular bread products, pasta, pizza, and cereals. However, gluten also may show up unexpectedly in foods such as soy sauce, canned soups, licorice, imitation crab meats, broth, beer, and products made with malt vinegar, malt flavoring, or malt extract.

People with diabetes should also check all medications they take to ensure that they do not contain gluten as an excipient ingredient. This can be done with the help of a knowledgeable pharmacist or through various websites, including www.glutenfreedrugs.com. In addition, it is important to use gluten-free products to treat low blood glucose (i.e., glucose gels or tablets). Gluten information can be found on manufacturer websites or on the product packaging.

The FDA's 2013 gluten-free labeling rule was a culmination of many years of work in the gluten-free community and within the FDA. It is intended to help consumers following a gluten-free diet easily identify gluten-free foods. It also provides standardization of what the term "gluten-free" means on the food label (7). It is important to note that manufacturers are not required to label foods gluten-free; rather, this voluntary rule sets a standard for the use of the term. According to the FDA's rule, the term "gluten-free" can be used on the food label if a product contains <20 ppm of gluten (7). Unlike the Food Allergy Labeling and Consumer Protection Act (38), which only took ingredients into account for gluten-free labeling, the 2013 gluten-free label ruling also takes into account potential contamination of gluten-free products at any point in production. Additional details about the gluten-free labeling rule are found in Table 1.

Coexisting Diabetes and Celiac Disease: Special Challenges

For patients with concurrent diabetes and celiac disease, the gluten-free diet must be carefully planned to meet nutritional needs while controlling blood glucose. This is best accomplished through consultation with a registered dietitian nutritionist (RDN) who is experienced in treating celiac disease and diabetes. The carbohydrate and fat content of gluten-free foods often is higher than in gluten-containing foods (29). In addition, the fiber content is typically lower, particularly if individuals eat the majority of grain servings in the form of rice-based, refined, and processed foods. Early studies in this area found that gluten-free foods may have a higher glycemic index than comparable gluten-containing foods, but more recent research does not support this conclusion (15). It is important for patients to read the labels of gluten-free foods for carbohydrate content and because serving sizes may differ from those of similar gluten-containing foods.

Improve the Nutritional Profile of the Gluten-Free Diet

Good sources of fiber in the gluten-free diet include fruits and vegetables, beans and legumes, and gluten-free grains, in particular buckwheat, quinoa, millet, sorghum, and teff. Table 2 provides a list of practical ways to encourage increased consumption of fiber and whole grains on the gluten-free diet. Patients should be advised only to purchase grain products specifically labeled gluten-free because of potential contamination of grains in the fields, in transport, and during processing (39).

Many newly diagnosed patients with celiac disease present with deficiencies in calcium, vitamin D, and iron (40). Levels of these vitamins and minerals should be tested at regular intervals by the provider, and supplementation should be prescribed if necessary. Calcium and vitamin D deficiencies can be exacerbated by secondary lactose intolerance, which is common in those with newly diagnosed celiac disease because of damaged villi and reduction in the amount of available lactase enzyme (41). Those with secondary lactose intolerance should be counseled about other sources of dietary calcium, including cheese, which is often very low in lactose; fortified orange juice; fortified soy or rice milk; collard greens and spinach; and canned sardines and salmon. Good sources of iron in the gluten-free diet include beef, fortified gluten-free breakfast cereals, beans, quinoa, amaranth, and teff.

Patients with diabetes and celiac disease may choose to use nonnutritive sweeteners. Aspartame (brand names Equal and Nutrasweet), saccharin (brand names Sweet-n-Low or Sugar Twin), and stevia (brand names Sun Crystals and Truvia) are all gluten-free, according to manufacturers' websites. Sucralose (brand name Splenda) has no gluten-containing ingredients, but according to the manufacturer's website, the manufacturer does not test the final product for gluten content. Sweeteners containing sugar alcohols such as xylitol, maltitol, or sorbitol are gluten-free but can cause significant gastrointestinal upset (42). This can often be mistaken for a gluten reaction.

Key Counseling Tips

Patients with diabetes who inquire about adopting a gluten-free diet should be informed about the potential nutritional risks of the diet for those who do not absolutely require it for the treatment of celiac disease or NCGS. In addition, patients should be instructed not to experiment with

the gluten-free diet without proper testing to rule out celiac disease. For those with diagnosed celiac disease and concurrent type 1 diabetes, intensive management with an experienced RDN is necessary. With careful planning that takes into account carbohydrates, fiber, vitamins, and minerals, those with diabetes and celiac disease can achieve a balanced and enjoyable diet.

Duality of Interest

No potential conflicts of interest relevant to this article were reported.

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