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POSITION STATEMENT

Gluten-free diet for pediatric patients with coeliac disease: A position paper from the ESPGHAN gastroenterology committee, special interest group in coeliac disease

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Abstract

Background and Objective: Coeliac disease is a chronic, immune-mediated disorder for which the only treatment consists of lifelong strict adherence to gluten-free diet (GFD). However, there is a lack of evidence-based guidelines on the GFD dietary management of coeliac disease. This position paper, led by the Special Interest Group in coeliac disease of the European Society of Pediatric, Gastroenterology Hepatology, and Nutrition, supported by the Nutrition Committee and the Allied Health Professionals Committee, aims to present evidence-based recommendations on the GFD as well as how to support dietary adherence.

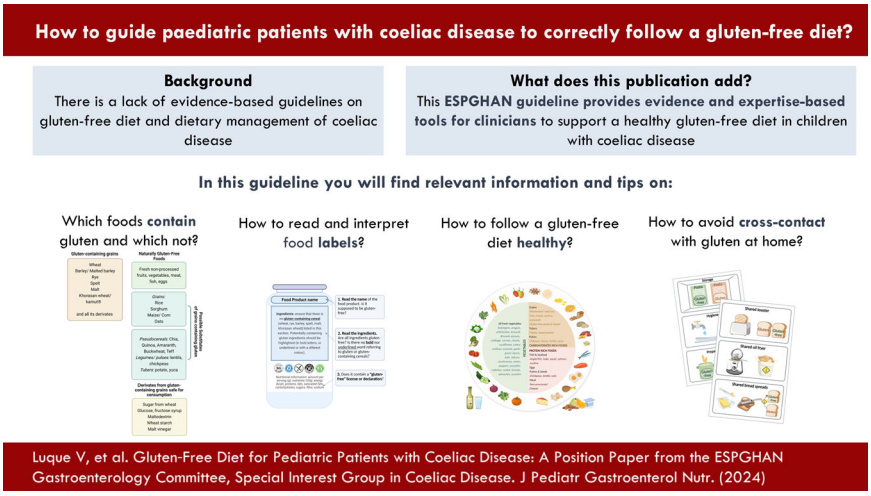
Methods: A wide literature search was performed using the MeSH Terms: "diet, gluten free," "gluten-free diet," "diets, gluten-free," "gluten free diet," and "coeliac disease" in Pubmed until November 8th, 2022.

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[Correction added on 21th March 2024 after first online publictaion: "Results" heading was added and all subsequent headings were renumbered.]

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Results: The manuscript provides an overview of the definition of the GFD, regulations as basis to define the term "gluten-free," which foods are naturally gluten-free and gluten-containing. Moreover, it provides recommendations and educational tips and infographics on suitable food substitutes, the importance of reading food labels, risk of gluten cross-contact at home and in public settings, nutritional considerations as well as factors associated to dietary adherence based on available evidence, or otherwise clinical expertise.
Conclusions: This position paper provides guidance and recommendations to support children with coeliac disease to safely adhere to a GFD.



KEYWORDS
children, diet adherence, dietary recommendations, food labeling, gluten cross-contact

1 | INTRODUCTION

Coeliac Disease (CD) is a chronic, immune-mediated disorder for which the only treatment consists of lifelong adherence to a strict gluten-free diet (GFD).[1] However, there is a lack of evidence-based recommendations or guidelines on the dietary management of CD.[2] This position paper, led by the Special Interest Group in CD of the European Society of Pediatric, Gastroenterology Hepatology and Nutrition, supported by the Nutrition Committee and the Allied Health Professionals Committee, presents a comprehensive review of the definition of the GFD considering regulations as basis to define the term "Gluten-free," and provides recommendations for health-care professionals to prescribe, educate, and support adherence to a safe GFD in pediatric CD patients. Furthermore, this position paper reviews nutritional risks of a GFD, and provides recommendations how to improve the quality of the GFD.

What is Known

- Coeliac disease is a chronic disorder for which the only treatment consists of lifelong adherence to a strict gluten-free diet.
- There is a lack of evidence-based recommendations and guidelines on the nutritional management of coeliac disease.

What is New

- This position paper is the first ESPGHAN position paper to provide evidence-based and experience-based recommendations on gluten-free diet in pediatric coeliac disease.
- Infographic material is provided for the given recommendations.

2 | METHODS

A wide literature search was performed to find available literature published before December 31, 2020 using MeSH Terms including "diet, gluten free," "gluten-free diet," "diets, gluten-free," "gluten free diet," and "CD" in Pubmed, without age restrictions (as several topics were age-independent, such as cross-contact). Later, papers including only adults and dealing with specific issued not applicable to children/adolescents were excluded.

Two pairs of two authors (C. R., P. C., A. V., E. H.) (double selection with cross-checking evaluation)

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performed the selection of relevant papers based on the following predefined questions or topics and limited to mainly original data: implication of different healthcare professionals in the dietary management of pediatric patients with CD; what is the safety of oats in the GFD; reading, interpreting, and understanding food labels; gluten cross-contact in the food industry; avoiding gluten cross-contact at home: gluten cross-contact in restaurants; gluten in medical drugs and cosmetics; what is a healthy GFD: nutritional quality and risks; multilevel determinants and supporting adherence to the GFD in children. For given recommendations, an evidence-based approach was used whenever possible, and matched with clinical expertise when evidence was not sufficient. Graphical educational materials based on recommendations are provided (graphics created with Biorender.com).

3 | RESULTS

The search retrieved 2225 papers. The final selection included 288 articles, from which 75 provided data to respond the prespecified questions. To avoid a large time gap between the search of articles and the final publication, we updated our review by performing the same search from January 1, 2021 to November 8, 2022. The search update retrieved 309 articles, from which 37 were preselected and 21 finally included. Furthermore, 72 references from other sources (either from primary articles or specifically searched, such as regulations) were added. Overall, 168 publications were used to extract all relevant information, to summarize the available evidence and to draw conclusions and recommendations (flow chart as Supporting Information S1, Figure 1).

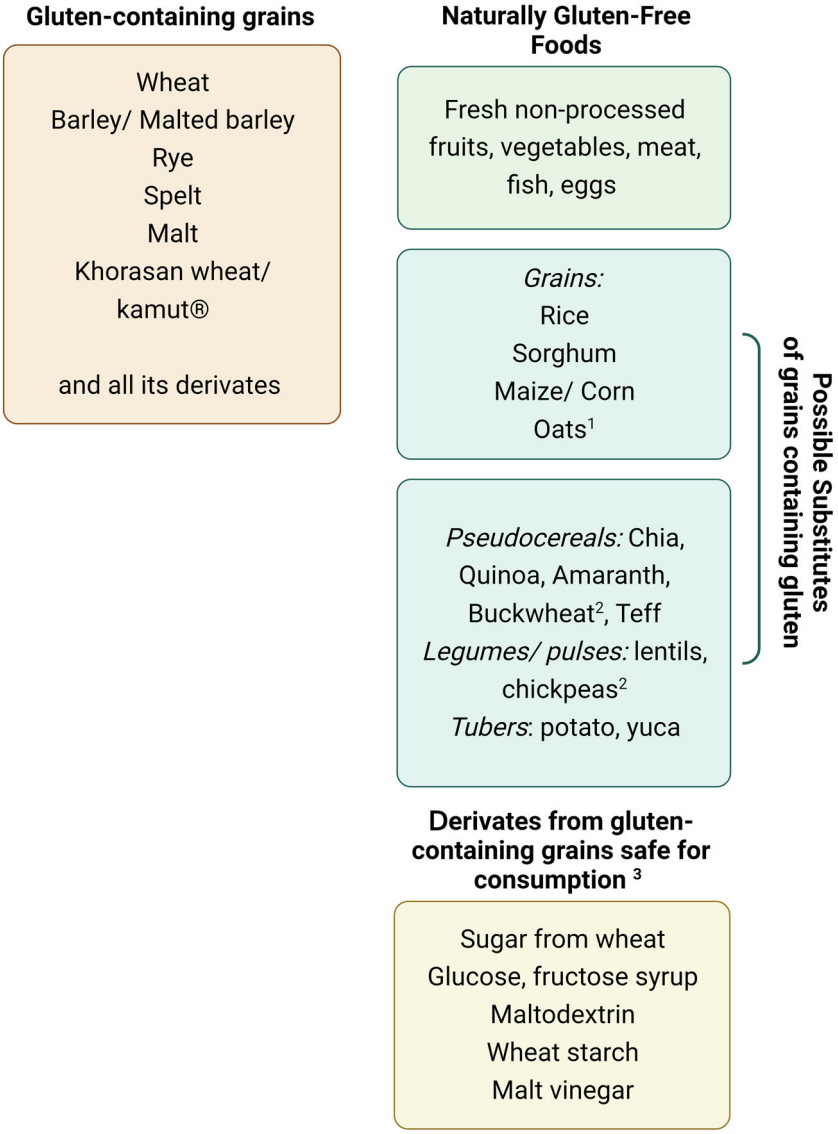


FIGURE 1 Foods containing gluten and gluten-free foods. (1) Oats, although being naturally gluten-free, should be consumed only if labeled as "gluten-free" (discussion and recommendations in a dedicated section). (2) Some pseudocereals (e.g., buckwheat), lentils, and maize, are also naturally gluten-free but may have cross-contact with gluten (especially when consumed as a flour, as the processing increases the risk). Thus, products tested regularly and using special symbols meaning "controlled and safe for celiac patients" would be advisable for patients with coeliac disease. (3) Derivates from gluten-containing grains such as malt vinegar or sugar from wheat can be safe for consumption as far as they are labeled as "gluten-free" (as the amount of gluten could exceed 20 mg/kg depending on the procedure).

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TABLE 1 Statements concerning gluten content in European Union Regulations on the provision of food information to consumers.

Regulation	Statements concerning gluten content
European Union Regulation No.1169/2011 (Annex II)	*The Regulation on the provision of food information to consumers:* Cereals containing gluten, namely wheat, rye, barley, oats, spelt, khorasan wheat (kamut®), or their hybridized strains, and products thereof, except: 1. wheat-based glucose syrups including dextrose and the products thereof*, 2. wheat-based maltodextrins and the products thereof[1], 3. glucose syrups based on barley, 4. cereals used for making alcoholic distillates including ethyl alcohol of agricultural origin**So far as the process that they have undergone is not likely to increase the level of allergenicity assessed by the Authority for the relevant product from which they originated*
Commission Implementing European Union Regulation No.828/2014	*Regulation on the requirements for the provision of information to consumers on the absence or reduced presence of gluten in food:* "Gluten-free statement may only be made where the food as sold to the final consumer contains no more than 20 mg/kg of gluten." (Annex)

3.1 | GFD

3.1.1 | Evidence-based definition of GFD

The term "gluten" defines a complex mixture of hundreds of related but distinct storage proteins present in wheat (mainly gliadin and glutenin), rye (secalins), barley (hordeins), and oats (avenins).[3] The protein content, composition, and distribution of gluten components varies between different wheat varieties, with about 80% of wheat proteins being gluten proteins.[3,4]

The term "gluten-free" applies to foods and food products, with a maximum gluten content defined in the Codex Alimentarius, and implemented and regulated by national or international authorities (detailed below). The definition is based on evidence on intakes considered to be medically safe in patients with CD as well as wheat allergy patients.[5] A recent review to elucidate the daily safe amount of gluten from published works which estimated a range from 10 to 100 mg/day, and stated as conclusion that 50 mg gluten per day appeared to be safe, but mucosal changes can be triggered in some individuals with as little as 10 mg of gluten daily.[6] Reviews considered the limited existing number of studies, which are in turn heterogeneous and include both children and adults, thus, adding difficulty to draw conclusions.

3.1.2 | Regulations to define the term "Gluten-Free"

The Codex Alimentarius Standard: Foods for special dietary use for persons intolerant to gluten (Codex Stan 118-1979. Adopted in 1979. Amendment: 1983 and 2015)[7] defines gluten-free foods as:

1. Consisting of or made only from one or more ingredients which do *not* contain wheat (i.e., all Triticum species, such as durum wheat, spelt, and Khorasan wheat, which is also marketed under different trademarks such as kamut®), rye, barley, oats, or their crossbred varieties, and the gluten level does not exceed 20 mg/kg in total, based on the food as sold or distributed to the consumer, and/or
2. Consisting of one or more ingredients from wheat (i.e., all Triticum species, such as durum wheat, spelt, and Khorasan wheat, which is also marketed under different trademarks such as kamut®), rye, barley, oats, or their crossbred varieties, which have been specially processed to remove gluten,* and the gluten level does not exceed 20 mg/kg in total, based on the food as sold or distributed to the consumer.

Furthermore, the Codex Alimentarius Commission Standard states that "Oats can be tolerated by most but not all people who are intolerant to gluten. Therefore, the allowance of oats that are not contaminated with wheat, rye or barley in foods covered by this standard may be determined at the national level."

In the European Union (EU), the Codex Alimentarius standard is implemented by the European Commission by means of the EU Regulation No. 828/2014. Moreover, the Regulation (EU) No. 1169/2011 on the provision of food information to consumers adds further protection and aims to guarantee their right to information.

Annex II within this regulation contains the list of substances or products causing allergies or intolerances, divided in 14 different categories. Indication of any ingredient or processing aid derived from a substance or product listed in Annex II, used in the manufacture or preparation of a food and still present in the finished product, even if in an altered form, is mandatory. Table 1 presents essential information provided in EU Regulations.

*Gluten removal processes involve the use of cultivars bred from specific grain mutants, which lack gluten protein types, extensive extraction of gluten proteins, fermentation, or enzymatic gluten degradation through protease treatment, among others). To guarantee the safety of processed food for patients with celiac disease, analytical confirmation is required to confirm that the gluten content does not exceed 20 mg/kg.

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3.1.3 | Naturally gluten-free foods: Nonprocessed products

Fresh, unprocessed foods without gluten from wheat, rye, barley, and its derivates, and without gluten cross-contact, are considered to be gluten-free (Figure 1).[8] All types of fruits and vegetables, if fresh or dried, are considered safe and can be consumed by patients with CD without any restriction.[9] All types of fresh and nonprocessed meat, fish, eggs, plain dairy foods, milk, tubers, oils, and fats can also be safely incorporated in a GFD.[9] Some grains (specified below) and legumes (peas, beans, lentils, etc.) are naturally free of gluten as well, however, considerations on potential cross-contact will be discussed in this paper. Some minimally processed food products are considered to be gluten-free, although there is no specific declaration according to EU regulations. These foods are mainly based on one gluten-free ingredient, such as canned fruits and vegetables, frozen peas, dairy products, and cheese or fats.

Water, fresh fruit, and vegetables juices, as well as coffee and tea are gluten-free and as such, they can form the basis of coeliac patients' hydration. Alcoholic beverages are not always safe: while wine is gluten-free, beer contains gluten, and other form of spirits (such as whiskey, gin, etc.) or liquors must be checked for gluten content. Natural seasonings such as salt, pepper, and vinegar are gluten-free. However, in all processed and ready-to-eat foods, seasonings, and mixed spices, the gluten content must always be controlled by reading the ingredients list.

3.1.4 | Gluten-containing cereals and gluten-free substitutes

Gluten is found in all wheat, barley (including malted barley), rye, spelt, and Khorasan wheat (kamut®) varieties and its derivates (Figure 1).[10] One ancient isoform of wheat called *Triticum monococcum* was suggested to be safe for coeliac patients, from a one single-blind crossover study,[11] however, it was demonstrated to be toxic for patients with CD and should not be included in a GFD.[12,13]

Some food ingredients can be specially processed to reduce gluten content by substituting gluten-containing ingredients.[14] Specially processed (deglutinated) wheat starch used in labeled "gluten-free products" can safely be incorporated in the GFD,[15–17] and has shown to improve the texture of breads.[18] Moreover, there is evidence that hydrolysates from wheat, including glucose syrup and maltodextrins derived from wheat, are safe to include in a GFD as well,[19,20] as protein residues in these falls below the <20 mg/kg gluten threshold.

Several naturally gluten-free cereals, pseudocereals, legumes, and tubers may serve as substitute foods and the base for flours and starches in gluten-free substitutes (Figure 1). These can be used to safely bake gluten-free products.[21] Rice can be integrated in all of its forms: either white or brown (more common in western countries), basmati (more common in India) as well as pigmented (more common in Asia).[22] Other suitable cereal substitutes are sorghum and maize,[23] as well as pseudocereals[24] chia, quinoa, teff, amaranth, and buckwheat.[23,25–27] However, whether gluten-free grains may have cross-contact with gluten and recommendations will be discussed in the following sections.[21]

As a curiosity, the topic of whether "ancient" wheat varieties could potentially have lower proportions of gluten has been a subject of discussion. However, recent research has refuted this belief.[28]

3.1.5 | Safety of oats

The potential toxicity of avenins in oats and frequent gluten cross-contact has raised concerns regarding coeliac patients.[29] However, oats are an important source of fiber as well as whole grain and has been shown to improve the taste, satiety as well as variation in the GFD.[30–32]

In Europe, since 2009 (with the EC 41/2009 regulation, replaced by 828/2014/EU, implementing regulation joined to 1169/2011/EU regulation)[33] and since 2013 in the United States,[34] referring to Codex Standard,[7] controlled oats (oats that are not contaminated with wheat, rye or barley) may be sold as gluten-free, provided a gluten cross-contact controlled level ≤20 mg/kg.

Several publications have shown that avenins are free of the known CD-related immunogenic epitopes, and that T cells recognizing avenin-specific epitopes have seldom been found in CD patients.[35]

A systematic review and meta-analysis as well as long-term studies on patients, have shown that controlled oats have no negative effect on symptoms, histology, immunity, or serologic features,[36] and may safely be a part of the GFD.[29,33,34] It has been estimated that about 10 times the average daily intake of controlled oats would be required to induce a toxic mucosal reaction.[37] However, the quality of available evidence on the intake of controlled oats in coeliac patients is considered to be low because of the heterogeneity in studies design. Hence, the role of oats in the GFD still remains a debate.[38,39]

Recent reviews and position papers agreed to report that controlled oats are well-tolerated by most CD patients in moderate amounts (20–25 g/day for children; 50–70 g/day for adults)[37,40] and in some publications in higher amounts (from 40 up to 100 g/day).[36,37,40,41] Some authors recommend to delay the introduction of oats for 6 months after the start of GFD to reduce the potential immunogenicity of some oats' varieties.[36,40] However, this approach has recently been contested.[41]

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3.1.5.1 | *Recommendation on oats in GFD*

Controlled oats (not contaminated with wheat, rye, or barley and so are labeled gluten-free) may be included as part of the GFD in amounts up to 20–25 g (dry)/day in the pediatric population.

3.2 | Identifying commercial gluten-free and gluten-containing food products

3.2.1 | Importance of understanding food labeling

Nonadequate labeling of food products is widely recognized as a barrier for adhering to a GFD, especially in countries such as the United States (regulations in 2004)[42] and India[43,44] where regulations are less strict than in the EU. Patients perceive insufficient, confusing, unclear, or unappealing labeling as a barrier for adherence to the GFD.[45–47] When patients from the Canadian Coeliac Association were asked to select two items that would improve their quality of life, 63% selected a better labeling of gluten-containing ingredients.[48] In the recent decade, EU regulations on labeling gluten-containing ingredients improved, however, to our knowledge, there is no data on how patients perceive the current EU labeling regulations.

Studies have shown that a large proportion of adult patients with CD, including those reporting strict adherence to the GFD, could not properly identify gluten-containing/gluten-free packaged foods,[49–51] and there was no improvement over time.[51] As this may be one of the reasons for unintentional gluten intake in coeliac patients, education on how to interpret food labels might be a cornerstone of adherence to the GFD.

3.2.2 | Voluntary information in food labels

In addition to the mandatory information as stated by EU Regulations (summarized in a previous section in this manuscript), some voluntary information could be displayed in the product package.

Licensed gluten-free products are required to meet certain criteria to ensure that they are gluten-free, both in terms of the ingredients and the production process, according to the licensing entity. The Crossed Grain Trademark is provided by the Association of European Coeliac Societies (AOECS) and national patient societies support its use. The license provides producers and retailers the right to use it on their gluten-free products (processed or made up of more than one ingredient), in more than 30 European countries. Food products with the symbol should be recorded in an EU registry and are considered to be safe. There are other gluten-free trademarks (see others at https://www.brcgs.com/our-standards/gluten-free-certification/) which also certify the safety. Some symbols and "gluten-Free" declarations are not accredited; however, the EU regulation (No. 828/2014) specifies that the "gluten-free" statement may only be used when the food product as sold to the final consumer contains no more than 20 mg/kg of gluten.

Precautionary declarations (PAL, "Precautionary Allergen Labeling") such as "May contain (traces of) gluten/wheat" or "This food product has been processed in a factory where gluten-containing products are made" can be stated but are not mandatory. These declarations are not regulated and remain uncertain at the moment. Presently, such declarations do not indicate the presence of gluten in the product; rather, they suggest that the product (or at least one of its ingredients) could have been in contact with gluten, potentially containing (or not) an uncertain amount of gluten. Furthermore, since PAL is not mandatory, the nondisclosure of potential cross-contact does not guarantee a lower risk. PAL regulation is currently under discussion by scientific and regulatory bodies (Codex Committee on Food Labeling). Finally, the different country regulations on label declarations in a globalized world when ingredients from different origins could be used in the same factory adds to the difficulties in interpretation of label information.[52]

All in all, scarce data has been published on the frequency and amounts of gluten cross-contact in food products with or without PAL. Thus, the potential impact that consuming these food products could have on the child's diet is unknown and is discussed below.

The combination of the different uses of mandatory versus not mandatory declarations complicates understanding food labels. Figure 2 shows a summary of mandatory and voluntary food labeling.

3.2.3 | Recommendations and education tips on reading food labels and choosing food products

Based on European regulations and on available evidence, herewith, we provide practical educational tips to introduce patients and families to reading and interpreting food labels to support adherence to the GFD. A stepwise approach is proposed in Figure 3.

Whenever possible, it is recommended to primarily use foods labeled "gluten-free," including plain legumes, maize, or buckwheat (if frequently used in large quantities).

However, as there is a possible low likelihood of cross-contact of noncertified food products (discussed in the section below on gluten cross-contact), the eventual consumption of a small food portion of a noncertified food product in an overall diet, with mainly certified food products, may be safe. For example, using a noncertified powdered spice for seasoning poses a low toxicity risk, while consuming a full portion of noncertified legumes poses a higher risk. However,

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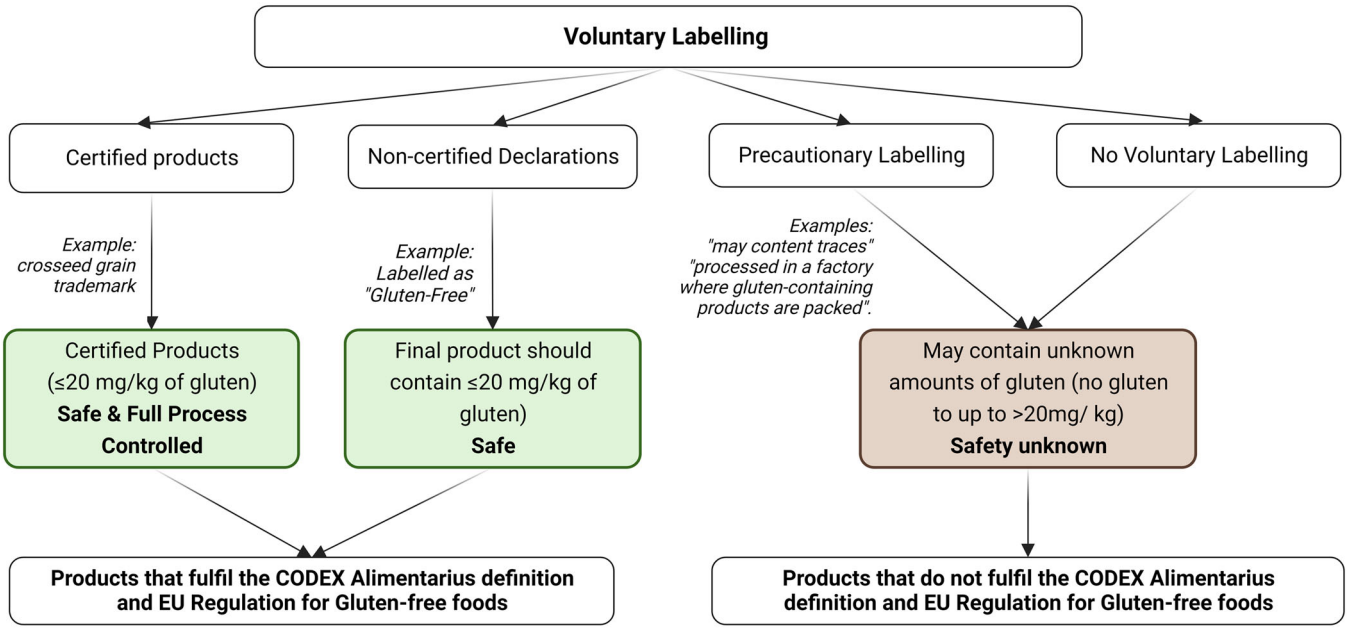


FIGURE 2 Voluntary information to appear in food labels under European regulations. This does not apply to foods that cannot be labeled as "gluten-free" according to European regulations, as those minimally processed which are not supposed to contain gluten, such as canned fruits and vegetables, dairy, butter spreads, cheese, and so on.

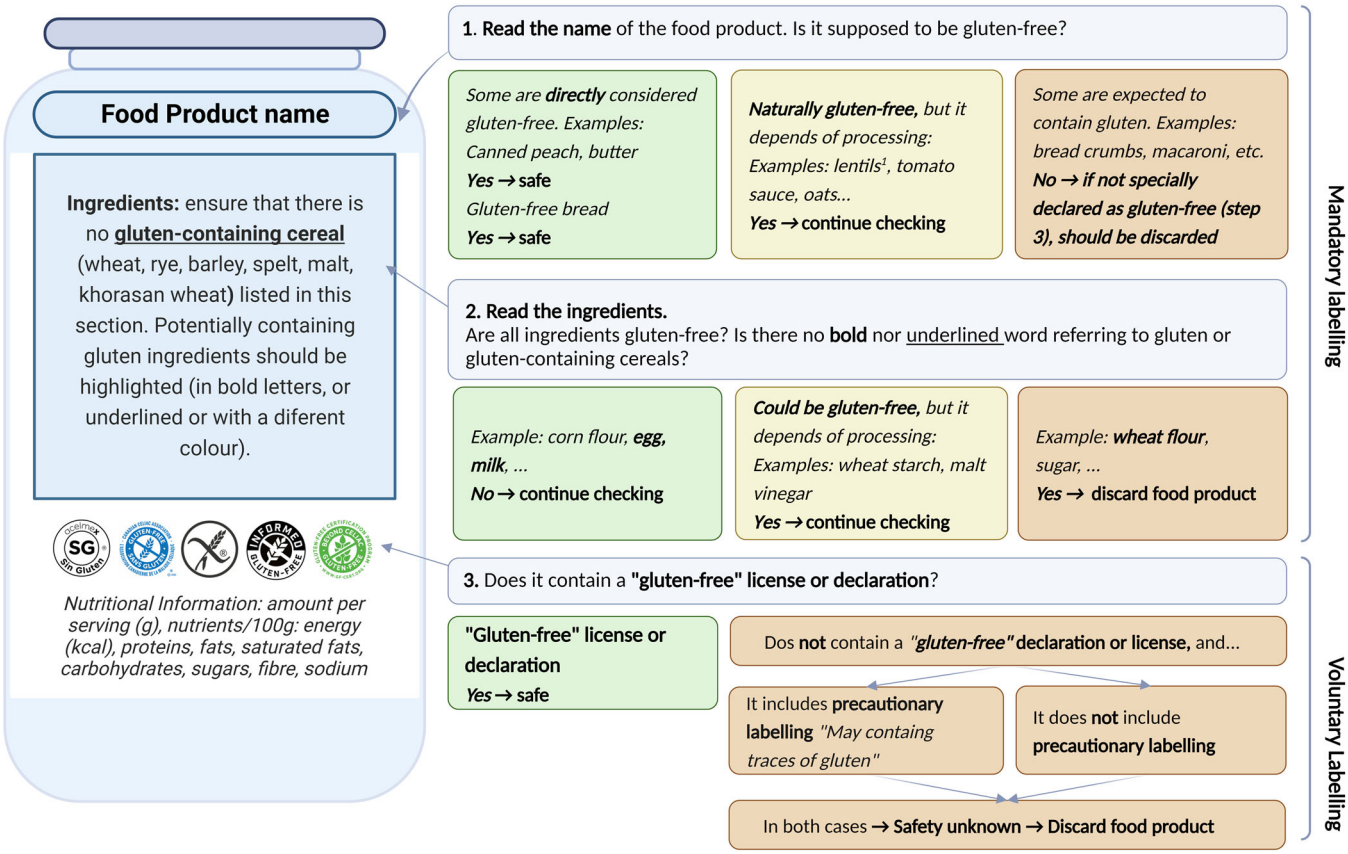


FIGURE 3 Practical tips to read labels from processed foods for patients following gluten-free diet. Some foods, which are not supposed to contain gluten, are not allowed to be labeled as "gluten-free" according to the EU regulations, such as canned fruits and vegetables, dairy, butter spreads, cheese, lentils, and so on. Those foods are naturally gluten-free and usually are minimally processed or the industrial process do not require potentially hazardous ingredients. *In the case of lentils, buckwheat, or maize products, those tested regularly and using special symbols meaning that they are controlled and safe for celiac patients would be advisable for patients with coeliac disease.

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further studies are needed to perform specific recommendations in this respect.

3.2.4 | Recommendation on identifying gluten-free prepacked commercial food products

Patients should be recommended to primarily choose food products either licensed or declared "gluten-free." Food products without these declarations, either with or without PAL, represent an unknown safety risk for the patient, which must be assessed considering different factors (see cross-contact section).

3.3 | Gluten cross-contact

Gluten cross-contact happens when gluten is unintentionally transferred to a gluten-free food product. The cross-contact may happen at cultivation, harvesting, transportation of raw materials, handling, storage, industrial food processing, as well as in food preparations at home or in a restaurant setting. Cross-contact resulting in gluten-free food having a gluten content >20 mg/kg is considered to be hazardous to people with CD.

3.3.1 | Gluten cross-contact during production and in the food industry

There is evidence that specifically maize and buckwheat,[53–55] as well as legumes (including mainly lentils)[56] may have cross-contact with gluten, which may happen during different phases of production such as cultivation, harvesting as well as industrial manufacturing.

There are a few publications reporting on the frequency of gluten cross-contact in prepackaged foods not labeled "gluten-free." In Denmark, foods with PAL had a gluten content >20 mg/kg in 3.9% of products compared with 5.9% in foods without PAL,[57] with no statistical difference. In a study by Verma et al., 6% of food products without PAL and 2% of products with PAL, had a gluten content >20 mg/kg (no statistically significant difference between groups).[58] Oats and buckwheat where commonly included in the foods with >20 mg/kg. Analyses of foods in the Nordic countries showed no difference in gluten presence between foods with and without PAL (3.3% and 4.4%, respectively).[59] However, only two out of 167 tested products had gluten >20 mg/kg and the amounts were within the measurement uncertainty (21 and 27 mg/kg).[60]

In adults, the likelihood of developing mucosal damage in the CD population when eating foods not labeled as "gluten-free" in a regular diet, with or without PAL, together with certified products, was estimated to be low, at the level of 0.2%–3.2%.[57]

3.3.2 | Gluten cross-contact from food preparation

A study aiming to measure the level of gluten cross-contact in the daily diet of 69 children with CD and on a GFD,[60] food samples provided, 2.7% contained detectable amounts of gluten, and one out of 448 collected food samples contained >20 mg/kg. Of the study participants, 7% had unintentional gluten intakes with levels ranging from 0.2 to 4 mg. In patients eating products with cross-contact food, the daily gluten intake was well below the safety threshold of 10 mg/day. It is worth mentioning that these analyses would not only include cross contact from food handling, but also the possible gluten intake from foods which were not labeled GF.

3.3.3 | Gluten cross-contact at home

Available evidence on food handling, preservation, preparations, and utensils[61–65] at home is summarized and recommendations are provided in Table 2.

Subjects willing to participate in studies on cross-contact and unintentional gluten intake may be more adherent to the GFD than those who decline participation. However, the evidence presented from analyzing actual gluten content from cross-contact, supports that those situations previously believed to be hazardous, may actually not pose a large risk in patients adhering to the GFD. However, as the evidence on gluten cross-contact is limited, we recommend being cautious and to consider these factors when estimating the risk of consuming foods with potential gluten cross-contact:

1. The **possible amount** of gluten resulting from cross-contact in a food: does evidence support that it would result in >20 mg/kg? (e.g., cooking pasta in water used for gluten-containing pasta, or using a shared ladle for serving pasta).
2. The **frequency** of eating a food with possible cross-contact of gluten (e.g., using a small portion of a bread spread once per week, compared with on a daily basis).
3. The **size** of the food portion: for example, 20 g of butter with 20 mg/kg of gluten would result in 0.4 mg of gluten from cross-contact.
4. The **texture** of the food with possible gluten cross-contact (how sticky is it, and how much gluten-containing residues may be transferred).

However, further studies are needed to extend specific recommendations.

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TABLE 2 Available evidence on cooking preparations, utensils, and cleaning at home.

Evidence
Storage: No articles were found that investigated how gluten-free products should be placed in a home-like setting. However, when summing the evidence on risk of gluten cross-contact presented in this chapter, storing gluten-free foods on the same shelf, or in the same cupboard as gluten-containing foods is considered safe in the GFD.
Cleaning of surfaces, and hand hygiene: Water and soap are effective to remove gluten when cleaning surfaces where gluten has been handled.[60] Washing hands with water, water and soap, or wet wipes effectively removes gluten residues.[61]
Cleaning of kitchen utensils: Cleaning kitchen utensils, including knives, pots, ladles, and colanders, solely with water is enough to prevent cross-contact between kitchen utensils and gluten-free foods.[60,62] Wiping kitchen utensils with a cloth or towel which was in contact with gluten does not result in hazardous cross-contact.[62]
Using kitchen utensils: Using a shared knife to cut frosted cupcakes, resulted in a gluten content >20 mg/kg in two of 30 (7%).[60] Shared utensils (metal and wooden) for serving pasta or cutting bread did not result in gluten cross-contact.[62] No evidence were found comparing metal versus porous (e.g., wooden) kitchen utensils.
Preparing pasta: Cooking GF pasta in water where gluten-containing pasta had previously been cooked, results in gluten content >20 mg/kg (depending on the portion and water volume).[60,63] Sharing the same ladle and colander did not result in gluten cross-contact >20 mg/kg.[62]
Shared toaster: The risk of cross-contact at home when toasting gluten-free bread in a toaster where gluten-containing bread has been found to be low, as all samples tested in two studies had a gluten content well below 20 mg/kg.[60,64]
Home fried foods: Frying gluten-free foods in the same fryer after frying gluten-containing foods in a home-like setting, has shown to pose a low risk of cross-contact.[64]
Spreads: Using the same sandwich spreads for gluten-containing and gluten-free bread, resulted in gluten content >20 mg/kg in 11 of 60 (18%) of the samples with mayonnaise, six of 60 (10%) of samples with peanut butter, and one of 60 (2%) samples with jam.[64]

Abbreviation: GFD, gluten-free diet.

3.3.3.1 | *Hygiene recommendations on preparing foods at home*

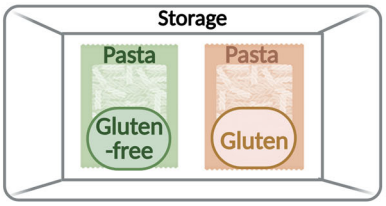
1. Gluten-free products should be stored in separate closed containers in the kitchen, clearly labeled to prevent mix-ups (most preferably in the original package). Gluten-free foods do not have to be stored in separate cupboards/shelves from gluten-containing foods.
2. Use clean kitchen utensils when preparing and cooking gluten-free foods. Washing up utensils, pots, and pans with clean water is enough to avoid risk of gluten cross-contact. Ensure to remove visible residues of foods.
3. Clean hands and kitchen surfaces before preparing gluten-free foods. Water is enough for removing gluten residues from hands, while water and soap should be used on surfaces. Remove visible residues of foods.
4. Be cautious to share utensils and make sure to adequately clean them between uses, especially when foods are sticky or wet as this increases the risk of gluten cross-contact. Using separate utensils, including colander, is preferred.
5. It is recommended to be cautious and consider using metal-based utensils when possible.
6. Cooking or baking gluten-containing products does not reduce gluten toxicity.
7. Shared toaster for both gluten-containing bread and gluten-free bread is a low risk of gluten cross-contact in home-like settings.
8. Gluten-free pasta should be prepared in clean water (without previous contact with gluten).
9. When using a shared colander for draining pasta, first drain the gluten-free pasta, and second the gluten-containing pasta.
10. In a home-like setting, oil used for frying gluten-containing foods may be used for frying gluten-free foods (e.g., potatoes). Caution should be taken with foods that leave considerable amounts of residues (e.g., battered or breaded foods). Gluten-free foods should preferably be fried before gluten-containing foods.
11. Caution should be taken when using bread spreads. Despite the high likelihood of gluten transfer, when the consumed portion is minimal, the overall gluten intake might be sufficiently low, to deem the risk of toxicity negligible.

A summary of recommendations on storing and preparing gluten-free foods at home to be used with patients is depicted in Figure 4.

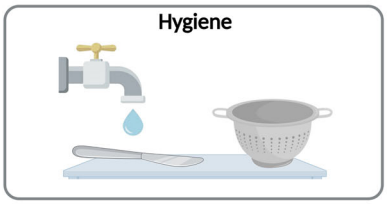
3.3.4 | Gluten cross-contact and safety in public settings

In the EU, regulations state that customers have the right to be informed of allergen contents in foods sold over the counter, such as in bakeries, restaurants, and so on. However, unintentional gluten cross-contact may still occur in food preparation and handling. The prevalence of hazardous gluten content in products sold as gluten-free varies between studies in different countries: 6% in Australia,[66] 10% in Ireland[67] (the majority >100 mg/kg), 0% in Italy.[60] Since 2009, the prevalence of gluten cross-contact in food services reported in the scientific literature has decreased, to overall 2.93% (95% confidence

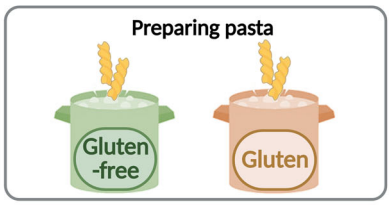
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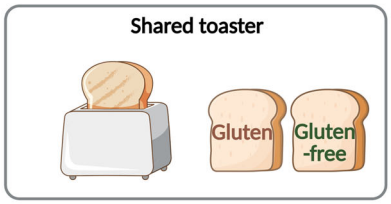
- Separate closed containers.
- Clearly labelled.
- Most preferably in original packages.
- No need to separate in different shelves.



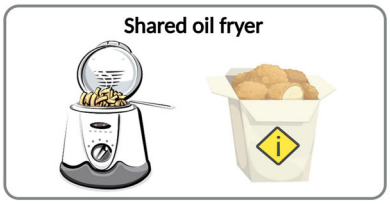
- Use clean kitchen utensils.
- Remove gluten residues from hands and utensils (special attention to residues from sticky foods).
- Water is enough for cleaning kitchen utensils, water and soap should be used on surfaces.



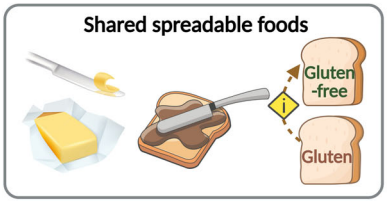
- Gluten-free pasta should be prepared in clean water (without previous contact with gluten).
- Beware that cooking/ heating gluten-containing products do not reduce gluten toxicity.



- Shared toaster for both gluten-containing bread and gluten-free bread is a low risk of cross-contact in home-like settings.



- Caution should be taken with foods that leave residues (ex. battered foods). In this case, gluten-free foods should preferably be fried in fresh oil (before gluten-containing foods).
- If re-using frying oil (e.g. fryer), use it only for gluten-free foods (e.g. potatoes).



- Caution should be taken with bread spreads (and bread residues in it).
- Even though the amount of spreads consumed is small, the risk of gluten transfer is high. When spreads are frequently consumed, the risk of gluten cross-contact may be sufficient to be toxic.

FIGURE 4 Hygiene recommendations on avoiding gluten cross-contact when preparing foods at home.

interval 1.60%, 4.91%).[68] In countries where a rigorous legislation is not in place, or that do not have the obligation to inform customers on allergens in foods,[65–68] the prevalence of hazardous gluten cross-contact seems to be more prevalent than in the EU. In the United States, pizza, pasta dishes, and dinner meals[69] were more likely to contain gluten. In Italy, gluten-free pizzas bought at certified restaurants[70] and regular restaurants[71] were both below 20 mg/kg. Naturally, gluten-free meals were more likely to cross-contact with gluten than meals labeled gluten-free.[68] In US restaurants, 1%[65] and 25%[72] of gluten-free foods fried in the same fryer as gluten-containing foods had a gluten content >20 mg/kg. Differences in prevalence of cross-contact in foods such as pasta and pizza served in restaurants in the United States compared to Italy may be the result of regulation differences. According to the type of restaurant, there might be different cross-contact risks. In the United States and Australia, chain and fast-food restaurants/franchise businesses were less likely to serve meals with gluten cross-contact.[66,69]

Some factors such as knowledge of the staff at public settings and well-established protocols may reduce the cross-contact risk. For instance, training

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on GFD in restaurant staff has shown to lower the risk of serving a meal with gluten cross-contact.[66] In this sense, the implementation of Hazard Analysis and Critical Control Point (HACCP) plan, good hygiene, and standard operation procedures,[68,73,74] as well as regular audits by authorities[75] are important to reduce the cross-contact risk. As an example, 2 m distance between the preparation of gluten-free meals and gluten-containing meals and compliance with standard hygiene measures rendered gluten contents ≤20 mg/kg in gluten-free meals, even during 4 h of cooking gluten-free and gluten-containing meals simultaneously.[76]

3.3.4.1 | *Recommendations on eating at public establishments*

1. People with CD are encouraged to inform the staff of the importance that the food is gluten-free, inform on what ingredients should be avoided, and to pose follow-up questions on their procedures to ensure their food being gluten-free.
2. Special attention should be paid to handling supposedly naturally gluten-free alongside gluten-containing foods when informing staff.
3. When consuming fried foods from public establishments, caution should be taken with foods fried in the same fryer as foods that leave considerable amounts of residues, as, for example, battered, or breaded foods.
4. For restaurants and food establishments, it is recommended to implement and follow HACCP plans, standard hygiene measures and operation procedures to reduce the risk of gluten cross-contact.

3.3.5 | Gluten cross-contact at school activities

As shown in one study on school projects with gluten-containing foods, gluten may be transferred to children's hands depending on the type of project.[62] There was a low risk of cross-contact in projects including dry materials and higher risk when using wet and sticky materials. Cleaning hands and surfaces after the activities effectively reduced gluten residues on the child's hands.

3.3.5.1 | *Recommendation on craft projects at schools*

Children with CD may participate in craft activities that include gluten-containing materials, as long as the material is not ingested and hands and surfaces are thoroughly cleansed afterward. Young children should be supervised to prevent ingestion and assure proper cleaning of hands.

3.4 | Safety of nonfoods

3.4.1 | Safety of medical drugs

Similar to foods, medical drugs should follow the labeling European regulation for "very low content" (≤100 mg/kg) and "gluten-free" (≤20 mg/kg).[77,78] According to the European Pharmacopoeia in the EU,[79] wheat and wheat starch must be declared as ingredients in medications, and the "gluten-free" statement (≤20 mg/kg) may be used. There is scarce data on the actual content of gluten in medical drugs. Most likely, the amounts are minimal considered the low amounts of wheat starch used in medical drugs resulting in a low daily dose of gluten.[80,81] Therefore, almost all medical drugs are considered to be safe.

3.4.2 | Safety of cosmetics

Lipstick and dental health products analyzed for gluten showed that four of 66 products had a gluten content >20 mg/kg.[82] Considering the low amount of unintentional ingestion of these products, the risk of using this type of products is considered to be very low for people with CD.

3.4.3 | Safety of dietary supplements

The use of gluten-containing ingredients in dietary supplements varies.[83] Gluten was detected in five of 21 (24%) dietary supplements on the European market.[84] However, as with medical drugs, the evidence on actual gluten amount in dietary supplements is scarce and should be further evaluated. As compared with medical drugs, dietary supplements in the form of vitamins and minerals, commonly have a low weight for daily dosage and would theoretically therefore, only contribute with a very low amount of gluten if a gluten-containing ingredient is used as an excipient.

The AOECS has published a statement (based on the document from the European Medicines Agency on wheat starch use as an excipient[78]), stating that all oral medical drugs should be considered safe for people with CD in regard to gluten content, except for hypersensitive individuals where a case-by-case evaluation may be needed.[85] Furthermore, it states that other types of medical drugs, hygiene products (including toothpaste) and cosmetics (including lipstick) are safe for people with CD.[85]

3.4.4 | Recommendation on nonfoods

Medical drugs, dietary supplements, hygiene products, including dental products, as well as cosmetics may

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safely be used for patients with CD without compromising strict adherence to the GFD.

3.5 | A healthy GFD

3.5.1 | Nutritional risks of the GFD

Children and adolescents on a GFD are at higher risk of insufficient intake of fiber[86,87] folate, magnesium, selenium, and vitamin D,[88,89] and have higher intakes of saturated and hydrogenated fats as well as sugars compared to children on a gluten-containing diet.[86,87,90] In 243 children with CD, most adhered to dietary patterns that were typical of a "Western Diet" or "High Fat-Western Diet," while <20% of the children adhered to a healthy "Prudent" dietary pattern.[91] Consumption of ultra-processed foods in children with CD has been associated with unhealthy inflammatory profiles.[92] In adolescents, high intakes of gluten-free bread, bakery products as well as sweet and salty convenience foods were associated with nonalcoholic fatty liver disease.[93]

There is conflicting evidence on iron and calcium intakes on a GFD.[87,89,94] There may be varying results because of differences in the availability of gluten-free products and their nutritional quality in different countries. Some micronutrient deficiencies identified in children at diagnosis have not resolved after 12 months on a GFD, and may require long-term monitoring and/or supplementation.[95] Nutrient deficiencies in patients with CD could be the result of malabsorption as well as of inadequate intakes. Some naturally gluten-free food sources are poor in minerals such as iron, calcium, and magnesium, and industrial food processing may further reduce the level of micronutrients.[96,97] The micronutrient content of commercial gluten-free products is rarely available on the nutritional label.[96] On the other hand, as products naturally containing gluten are commonly not the main food sources of several micronutrients, including iron, calcium, and magnesium, there may be other reasons for observed deficiencies. Studies have reported similar nutritional imbalances in children with CD as healthy controls, with insufficient intakes of several vitamins and minerals, as well as high intakes of saturated fats and low intakes in unsaturated fats.[98,99] Thus, some of the nutrient deficiencies reported may be the result of poor nutritional quality of gluten-free processed products, but also of unhealthy dietary patterns among children and adolescents in general.

Differences in fiber content, quality of fats and sugars, could also partly be a result of commonly reported low palatability of gluten-free products.[100,101] Compared to gluten-containing products, gluten-free alternatives are often based on starch and/or refined flours, have a higher content of saturated fats and sugars and less fiber, resulting in meals with higher glycaemic index.[87,102–104] A low nutritional quality of gluten-free products is one of the most important health concerns of the GFD. A concern that is even greater in patients with other co-morbidities such as diabetes, obesity, or food allergy that requires additional food restrictions and modifications.[105] Thus, gluten avoidance is not recommended for subjects without medically diagnosed gluten-related diseases (e.g., healthy subjects who have the perception that gluten is potentially harmful).[106]

3.5.2 | Improving the nutritional quality of the GFD

Several studies have reported possible benefits of using alternative gluten-free grains and pseudocereals as substitutes to improve the nutritional quality. Some of the proposed grains are, among others, amaranth and quinoa (sources of Vitamin E[107]), sorghum (high in thiamine), and millet (source of thiamine and carotenoids[107]).

In a comparative study on some of these grains,[24] amaranth, quinoa, and buckwheat were considered healthy ingredients for improving the nutritional quality of gluten-free breads with significantly higher levels of protein, fat, fiber, and minerals than in a control bread. One study compared two theoretical gluten-free dietary patterns; one "standard" gluten-free dietary pattern based on diet history records by a CD specialized dietitian, and one "alternative" gluten-free dietary pattern instead with similar intake of gluten-free foods such as controlled oats, high fiber gluten-free bread and quinoa.[24] The "alternative" dietary pattern resulted in higher intakes of protein, iron, calcium, and fiber compared to the "standard" dietary pattern. In children with CD, a higher adherence to a Mediterranean Diet was associated with greater bone mineral density.[108]

Independent of the grain source, there is increasing evidence that whole grains prevents the most common noncommunicable diseases. Besides the higher fiber content, whole grains contain up to 75% more nutrients than refined cereals; with higher proportions of vitamins, minerals, and essential fatty acids. Thus, whole grains such as controlled oats, quinoa, maize, or wild rice, may improve the overall quality of the GFD.[109]

Table 3 summarizes the above-mentioned nutritional risks as well as recommendations for improving the nutritional quality of the GFD.

The dietitian can properly assess the patients' adherence to the GFD and make individual recommendations to improve its nutritional quality. Patients educated by a dietitian are more likely to make healthier food choices.[110] In a recent intervention study on 72 children, there were significant improvements in their dietary habits when educated by a dietitian, with lower intakes of sugar and ultra-processed foods and overall increase of fruits and fiber[111] Thus, nutrition education of patients

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TABLE 3 Nutritional risks of dietary habits in the gluten-free diet.

Dietary habit	Nutritional risk	Recommendations for dietary improvement
High consumption of refined flours	Low fiber intake	• Increase whole grain products, pseudocereals, and flours from pulses and nuts • Increase vegetable and fruit intake
High consumption of highly processed starch-based products (e.g., bakery products)	High intake of poor-quality fats	• Education on food labeling to choose products with healthy fats and low sugar content • Chose fresh and/or homemade gluten-free products (bread for sandwiches and snacks, pizza base, etc.)
	High sugar intake	• Choosing fruits, low-sugar dairy products, and nuts as snack foods • Education on food labeling to choose products with low sugar content
	Low intake of magnesium	• Promote consumption of pulses and its flours • Promote nuts and seeds as snack foods • Promote the use of oats, millet, buckwheat, and sorghum varieties
	Low intake of calcium and vitamin D	• Increase low-sugar dairy products
	Low intake of iron	• Promote gluten-free sources of iron • Oats, millet, teff are also good sources of iron • Optimize the different iron sources (animal and plant) by combination with vitamin C
	Folates	• Increased consumption of leafy green vegetables • Consumption of gluten-free breakfast cereals (commonly fortified in European countries)

and their families by a dietitian may improve nutritional and health status.

Regarding clinical practice and from a psychological point of view, it is worth emphasizing that families should be addressed from a positive perspective. The fact that the child was diagnosed with CD could serve as a catalyst to a healthy diet by actively reading food labels and increasing the awareness of food processing.

3.5.3 | Composition of a healthy GFD

Recommendations for an overall healthy GFD do not differ from those for a regular healthy diet, however, there is a need to focus on healthy alternatives for grain-based foods. Main sources of carbohydrates should be naturally gluten-free foods such as whole grains and flours, pseudocereals, pulses, and tubercles (e.g., potato). The US Departments of Health and US Department of Agriculture recently proposed a healthy dietary pattern to include[112]:

1. Two to three portions of vegetables/day
2. Two to three portions of fruits/day
3. Three to six portions of grains/day
4. Two portions of milk and/or dairy/day
5. One to two portions of protein sources (animal or plant-based equivalent)/day
6. Five to seven portions of nuts/week
7. At least one to two portions of legumes/week

The proportions of main dishes should follow the composition of the Harvard plate,[113] including ½ of the plate for vegetables and fruits, ¼ of the plate for protein sources, and ¼ of the plate for carbohydrates, in the GFD choosing mainly naturally gluten-free products. Figure 5 shows an adapted healthy plate for children with CD.

3.5.4 | Recommendations for a healthy GFD

Healthcare providers should promote education on a healthy diet in patients with CD. General dietary recommendations are:

1. To avoid highly processed foods that are low in fiber and high in sugars and poor-quality fats. Foods with low glycaemic index and high-quality fats are recommended
2. To promote the consumption of whole grain gluten-free flours, including pseudocereals and pulses
3. Encourage homemade gluten-free foods
4. To promote the consumption of fruits and vegetables.

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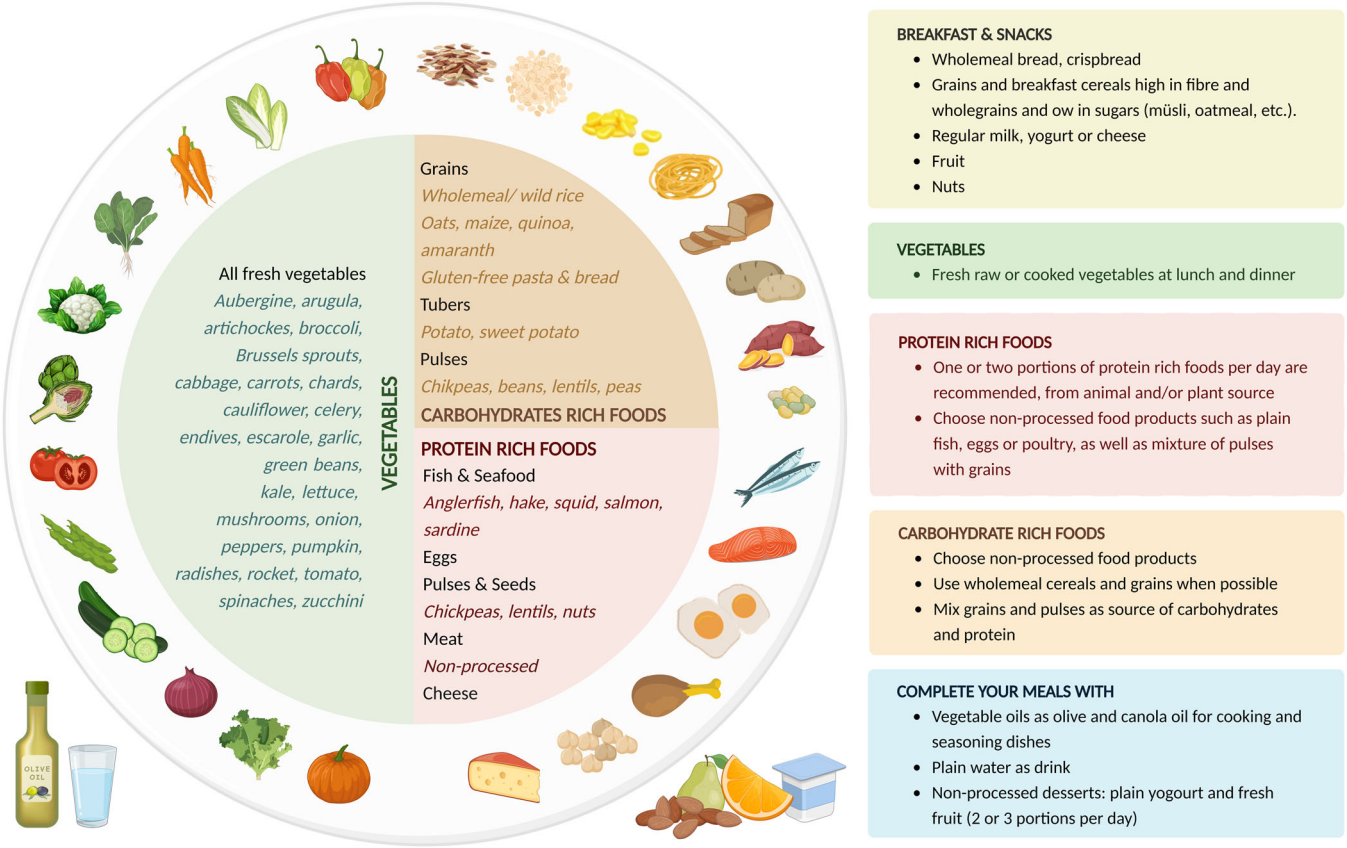


FIGURE 5 Healthy gluten-free plate. This figure represents how a healthy diet should be. Special attention to carbohydrate-rich foods proposed in this plate, should be made ensure the nutritional quality of the gluten-free diet.

3.6 | Education to start a GFD: Why, who, what, when, and how

3.6.1 | Why

To avoid long-term complications of CD, it is crucial to strictly follow a GFD. Education and continued support of children and their network (family, school, etc.) by a specialized healthcare team is the cornerstone of the treatment.

In a study assessing the knowledge, attitudes, and practices of parents of 2–15-year-old children with CD, parents received two educational sessions (which took place 2 weeks apart). Parents were asked to complete a validated questionnaire pre and postintervention. Self-reported patient's adherence between pre- and posteducational intervention showed a significant improvement in all variables.[114]

3.6.2 | Who

Physicians (pediatric gastroenterologists) are usually the first healthcare professional to inform the patient and family about the diagnosis and provide the first general information on CD and the GFD. As the GFD is complex and requires several skills in nutrition, food labeling, adaption to family food culture, a clinical dietitian trained in CD is recommended to give both the first as well as the continued education on the GFD.[42,115] The dietitian supports the adherence to the GFD,[116] adherence to healthier dietary habits,[111] is safe and cost effective in the follow-up care,[117] and patients appreciate the contact with the dietitian.[118]

Monitoring patients with both type 1 diabetes and CD is particularly challenging. It is noteworthy that some dietitians might be specialized in type 1 diabetes management but may lack expertise in CD, and vice versa. Additionally, endocrinologists may do not have adequate expertise in CD. Consequently, as in many other diseases, it is crucial to adopt a multidisciplinary approach to patient care.

Furthermore, as poor psychological well-being has been associated with risk of poor adherence to the GFD,[119] lifelong strict dietary adherence may at times require support from a psychologist to strengthen motivation, support adaptation to the diet, and improve quality of life.[120] Conversely, individuals who may benefit from psychological assistance are those who exhibit extreme vigilance toward adhering to the GFD, fear of gluten, and experience anxiety, as these factors could lead to the development of maladaptive eating behaviors.[121,122]

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3.6.3 | What

After receiving basic information on the disease and on the dietary constrains at diagnosis, patients should be informed of the importance of a lifelong adherence to a GFD and the health-related risks of poor dietary adherence, also in the absence of symptoms. Important topics for dietary counseling are information on gluten-containing as well as gluten-free foods, identifying hidden sources of gluten, ensuring adequate nutrients intake, planning healthy balanced meals, interpreting food labels, minimizing gluten cross-contact at home, and considerations when eating out of home (summarized in Table 4 checklist).

3.6.4 | When

Children with CD and their families become less interested in dietary education over time, thus, the greatest opportunity to teach patients and parents about the GFD is at the time of diagnosis.[123]

TABLE 4 Checklist of information and education to be provided at coeliac disease diagnosis to patients and parents by healthcare providers in a multidisciplinary team.

Healthcare provider and topics to be covered	
Pediatric gastroenterologist (at diagnosis)	□
Inform on the diagnosis of coeliac disease	□
Inform on the risk of developing other related autoimmune diseases	□
Brief information of the GFD	□
Stress that strict adherence to the diet is essential for clinical recovery	□
Stress that lifelong strict adherence to the diet is required to avoid complications, also in absence of symptoms	□
Discuss consequences of poor dietary adherence, also in absence of symptoms	□
Inform on follow-up plan, including regular disease monitoring and visits with a dietician	□
Address patients concerns and questions	□
Dietitian	
Inform on naturally gluten-containing vs. gluten-free foods	□
Educate on how to read food labels, what ingredients to avoid	□
Inform of how to minimize cross-contact with gluten-containing foods at home	□
Educate on strategies and tips for eating out of home	□
Educate on a healthy GFD and nutritional risks	□

Abbreviation: GFD, gluten-free diet.

However, even if gluten should be excluded a soon as possible after diagnosis, reaching full knowledge of all aspects of a strict GFD can take several weeks. In an anonymous survey on 137 adult patients, most of the participants needed approximately 6 months for mastering the skills related to identifying gluten-containing versus gluten-free foods, and longer periods for more specific and less frequently needed skills (such as medications and traveling).[124] Assessing the progression in skills acquisition is important for healthcare providers to be able to individualize education and suggest resources to facilitate adherence. A step-by-step approach is proposed in Table 4, which should be adapted to the patients' and professionals' needs. Patients should be evaluated at regular intervals by a healthcare team; every to every other year as recommended by a recent position paper of the ESPGHAN Special Interest Group on CD.[115] It is recommended to schedule a first follow-up visit, 3–6 months after the diagnosis. Intervals for further follow-up visits should take into consideration several factors, and be scheduled at a 6–12 months interval and every 12–24 months afterward.[115]

3.6.5 | How

In the last few years, alternatives to conventional education have shown to be effective and well-accepted by patients. For instance, a group-based education intervention was effective to increase knowledge and adherence to the GFD,[125] as well as improve gastrointestinal symptoms and quality of life in patients with CD.[126]

There are several new technology-based options such as online teaching and websites to consider. In a pilot study, centralized online teaching from a specialized center was tested. Education sessions were provided by a tertiary-care pediatric hospital once a month and held via a 2.5-h live videoconference at the patients' regional hospitals. This method was as effective as face-to-face sessions, however, with reduced travel time and costs.[127]

Nowadays, there are several e-learning platforms and online applications to help educate patients. An interactive e-learning module proved to be effective in delivering comprehensive and accessible information regarding the implementation of the GFD in children with CD.[128] Moreover, a GFD evaluation software package with more than 700 gluten-free foods and their macronutrient composition was developed as an educational tool that could be used also for dietary assessment.[129] Mobile applications have been suggested to be attractive and useful for self-management in adolescents.[130] A project funded by the European Commission called “Focus in CD” developed a website for educational purposes, for patients as well as

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healthcare professionals, which has been translated into several languages and can be found at https://celiacfacts.eu.

Patients should be made aware that not all websites and applications are evidence based, and thus, expert healthcare professionals in CD, should guide patients by recommending appropriate and suitable tools. Furthermore, healthcare professionals, with expertise in CD should recommend local or national support, such as from patients' associations which can provide not only reliable updated information on a GFD, but also helpful educational materials as well as social support. In adults, belonging to a CD association is linked to enhanced adherence to a GFD.[131]

In summary, a multidisciplinary team approach including a pediatric or adult gastroenterologist, a dietitian with expertise in CD, as well as a primary healthcare provider (general practitioner or general pediatrician) with continuous educational support, is of benefit to patients and their families and leads to long-term adherence to a GFD.

3.6.6 | Recommendations to start the GFD

1. Support and guidance from a multidisciplinary team, including a physician (pediatric gastroenterologist, gastroenterologist, or pediatrician) and an experienced dietitian is recommended.
2. Regular follow-up to monitor dietary adherence, nutritional status, and provide individualized training and support is highly recommended.
3. Support from new technologies, group-education sessions, as well as membership in regional patients societies may support the learning process and dietary adherence.

3.7 | Adherence to the GFD

Some of the difficulties when investigating adherence to the GFD include the definition of "strict adherence" and the different methods to assess adherence to GFD, which are most frequently subjective.[132] This section summarizes current adherence assessment methods and knowledge of influencing factors.

3.7.1 | Assessing adherence to the GFD

Methods to monitor dietary adherence in CD have been discussed in a recent ESPGHAN position paper; it is currently recommended to combine multiple methods (including tissue transglutaminase-IgA and questionnaires).[115] Roughly, clinical improvement and resolution of symptoms after establishment of the GFD after diagnosis are signs of adherence to the GFD, however, it is not sufficient to reflect mucosal healing. Adherence to the GFD can be assessed by systematic dietary interviews by a trained dietitian. It is time-consuming and has shown large variability,[132] although efforts have been made to standardize the methodology.[133] Shorter self-reported questionnaires are the Biagi questionnaire[134] and the Coeliac Dietary Adherence Test.[135] However, both have been validated for use in adults only and have shown weak sensibility to detect dietary transgressions in children; however, they may be useful to detect dietary transgressions in adolescents.[136,137]

The only objective noninvasive and valid biomarker to assess adherence to the GFD is the analysis of fecal gluten immunogenic peptides (GIP), which has proven to detect recent intakes not identified by serology or dietary questionnaires.[138,139]

3.7.2 | Adherence to the GFD in children and adolescents

A recent systematic review including 7850 children from 49 studies published up to 2019, showed a median adherence rate to GFD of 78% (23%–98%) in pediatric patients,[132] which varied with geographical area: Scandinavia 90%, Europe (excluding Scandinavia) 74%, and North America 79%. Adherence rates were similar regardless of the method used: 87% for biopsies, 81% by self-reports, 77% for structured dietary reports, 76% for serology tests, and 75% for GIP. More recent studies have reported adherence rates in pediatric patients within the range described,[137,139–141] including one study on adherence to the GFD during the lockdown for Covid-19 pandemic,[142] observing an improvement in compliance with the GFD by 29% in both children and adults. Another study showed an adherence of 90.6% according to food records and 65% through GIP detection in feces.[139]

3.7.3 | Factors influencing adherence to the GFD

Most of the research on adherence to the GFD has been carried out in adults. In children, especially in younger ages, parents' attitudes and family processes (such as planning ahead, bringing own food to social events, etc.) are important factors influencing dietary adherence.[143]

There is no clear association between adherence to the GFD and factors such as gender,[132,137,141] the presence of comorbidities other than anxiety and depression,[132,141] the presence of CD-related symptoms at diagnosis, the presence of extradigestive symptomatology, family history of CD or socioeconomic status.[132]

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Age and age at diagnosis have been observed as an important factor for adherence. Specifically, adolescence is considered to be a critical period were adherence is frequently poorer than in younger children, although some authors did not find such association.[132]

Low socioeconomic status may limit the access to gluten-free products, which commonly are more expensive,[144–146] and increase the economic burden of families including members with CD.[147–149] In some countries, policies have been established to facilitate the access to gluten-free foods in patients with CD.[150] Although the impact on adherence to diet has been associated to gluten-free foods prescription in adults, there is a lack of evidence on how economical reimbursement affects the dietary adherence in children with CD.[151]

Several factors that have been identified to influence adherence, either personal or situational factors (environmental barriers that hinder adherence and resources that promote it), are summarized in Figure 6.[47,132,137,141,143,152–164]

3.7.4 | Improving adherence to the GFD

A poor dietary adherence may be improved by addressing identified obstacles, which could be a combination of personal and environmental factors. Regarding personal factors, patient's knowledge (as well as parents') is crucial for adherence to the GFD. To our knowledge, the effect of interventions specifically addressed to regularly train (including label reading) children on the GFD to improve and support dietary adherence has not been studied. However, during adolescence, there is a transition process to shift the responsibility for adherence to the GFD from parents to the adolescent. This transition should be supported by healthcare providers,[165] and education on reading food labels would be one important topic to cover in follow-up. This training could also improve other personal factors, such as confidence in one's knowledge (self-efficacy expectations) and motivation (positive result expectation derived from successfully adhere to a GFD). Within the environmental factors, focus should be placed on reducing barriers (e.g., unavailability) and education of the family and social environment. From a psychological perspective, the Health Action Process Approach (HAPA)[166] offers a general model about the management of healthy habits in chronic illnesses. This model considers self-efficacy, results expectations, and removal of barriers among others, to effectively adhere to, and maintain a healthy habit. The HAPA model has been widely applied to different health-related areas,[167] it would be easily applicable to CD, but its implementation should be further investigated. The support from a trained psychologist should be considered in those

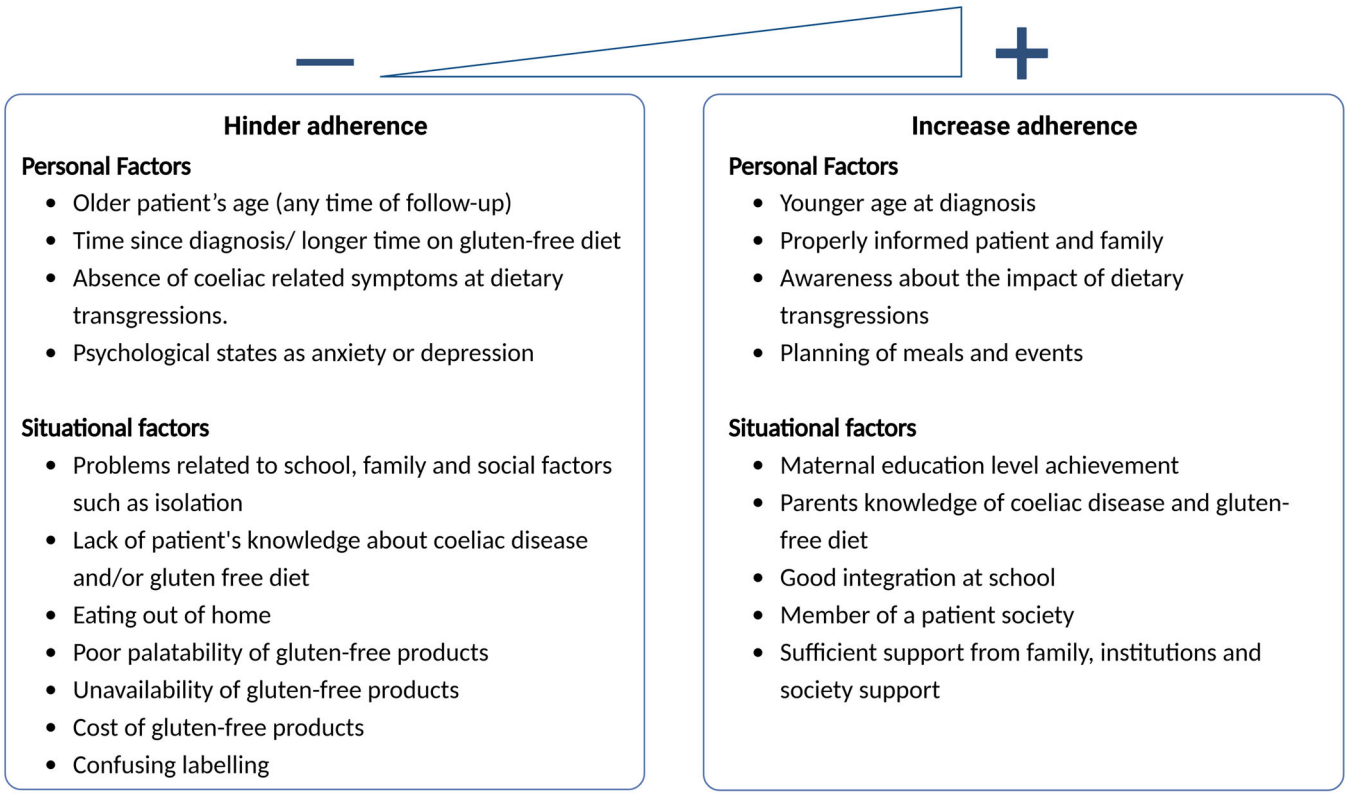


FIGURE 6 Summary of factors influencing adherence to the gluten-free diet in pediatric ages based on references.

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cases with persistent poor adherence to the diet and/or low quality of life.

3.7.5 | Tips and recommendations for supporting adherence in everyday life

At clinical follow-up, it is recommended to assess knowledge and skills of the patient and parents, and to train them accordingly:

1. The physician should assess knowledge of CD and on the impact of dietary transgressions on health.
2. The dietitian should assess knowledge of GFD, the ability to correctly identify gluten-free products and gluten-containing products (e.g., reading food labels), and skills to minimize the risk of gluten cross-contact at home and when eating outside of home.

Furthermore, day-to-day activities may challenge patients' dietary adherence. Some educational perspectives, based on clinical practice, which may help families could be:

1. Support to recognize and accept that gluten is present in everyday situations and learn strategies how to cope with it. It is not recommended to completely remove gluten from home if other family members do not have CD, as it serves as the first line education for the child, to find strategies to adhere to the diet out of home as well (dietitian, psychologist).
2. Relatives and friends should be trained on GFD and supervised by parents from the beginning. Unanimous criteria among parents and other family members should be promoted (dietitian).
3. Planning for meals out of home in advance, including those at families and friends and having strategies to ensure there are GFD options (e.g., bringing GFD alternatives when needed) (dietitian).
4. Recommend families to plan for travels; bringing gluten-free foods when needed, learning food habits and local regulations (dietitian).
5. Help finding strategies in situations where the adolescent has high risk of being noncompliant (dietitian/psychologist).
6. Recommend families to join patients' associations to share experience in support groups, be aware of relevant information such as safe restaurants in the area, e-learning materials, children camps, youngsters' special programmes, and so on (physician, dietitian, and psychologist).
7. Provide assistance to patients with inadequate parental and/or social support by engaging a psychologist or healthcare social worker to offer guidance within the patient's environment (psychologist, social worker).

3.8 | Patients' perspective

It is important to highlight the crucial advocacy that patients' associations have at local and national level, supporting its community. Patients' associations are represented in this scientific position paper by the AOECS. The AOECS emphasizes the importance of enhanced educational support for families raising children with CD. This should involve consistent follow-up from a proficient team including physician and dietitian (and psychologist and social worker when necessary). These professionals would administer evidence-based support programmes, while also advocating for national policies aimed at alleviating the economic burden experienced by these families.

4 | STRENGTHS AND LIMITATIONS

The strength of this position paper is the comprehensive overview of available evidence on which it has been based, although published data on which to base recommendations in some areas is scarce. However, the evidence has been complemented by the authors' clinical expertise. The position paper provides educational materials to be used by healthcare practitioners and families.

5 | RESEARCH GAPS

To increase the evidence on the GFD, more research would be needed on:

1. How much gluten is tolerated by children with CD and what is the health impact of occasional gluten intake.
2. Whether training children and adolescents on reading food labels enhances the adherence to the GFD.
3. The proportion of noncertified commercial gluten-free food products which could have cross-contact, and the toxicity associated with it.
4. The cross-contact risk related to handling and cooking practices at home, and when eating out.
5. Whether delaying the introduction of oats in the GFD has any beneficial effect on the patient's management.
6. There is a need for tools to efficiently assess adherence to the GFD.
7. The impact of prescription/economic reimbursement on adherence to the GFD in children should be analyzed.

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6 | CONCLUSIONS

Although scientific evidence addressing several aspects of the GFD is overall low, especially in the pediatric population, in this paper, we provide guidance and recommendations for adherence to a healthy GFD. Factors influencing dietary adherence are mainly related to patient and family knowledge about which foods are gluten-free, as well as about gluten cross-contact risks. Consequently, continuous education of patients, families, and their social network is one of the main pillars to achieve strict adherence to the GFD. This paper also stresses the need for regular follow-up after diagnosis by a multidisciplinary team in which the dietitian plays a key role, and the benefits of joining patients' associations. This comprehensive document provides also graphical educational materials to support patients' guidance. Providing professionals with evidence-based guidelines and better education tools to instruct patients on the GFD, may improve patients' future health.

CONFLICTS OF INTEREST STATEMENTS

V. L., L. N., A. V., and C. R. participate in industry-funded research or consultancy not related to this paper. The authors declare that the abovementioned grants and funds do not pose any conflict of interest for the development of the present manuscript and recommendations. The remaining authors declare no conflict of interest.

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