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## The Oslo definitions for coeliac disease and related terms

**Jonas F Ludvigsson,**

Department of Paediatrics, Örebro University Hospital, 701 85 Örebro, Sweden and Clinical Epidemiology Unit, Department of Medicine, Karolinska Institutet, 171 76 Stockholm, Sweden

**Daniel A Leffler\***,

Division of Gastroenterology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, 02215, USA

**Julio Bai,**

Department of Medicine, Dr C. Bonorino Udaondo Gastroenterology Hospital. Del Salvador University, Buenos Aires, (1264) Argentina

**Federico Biagi,**

Coeliac Centre/1st Dept. of Internal Medicine, University of Pavia, Fondazione IRCCS Policlinico San Matteo, P.le Golgi, 19, Pavia, 27100 Italy

**Alessio Fasano,**

Center for Coeliac Research University of Maryland School of Medicine, Baltimore, Maryland, USA

**Peter HR Green,**

MD Coeliac Disease center at Columbia University, New York, NY, 10032, USA

**Marios Hadjivassiliou, MD,**

Department of Neurology, Royal Hallamshire Hospital, Sheffield, 2JF UK

**Katri Kaukinen,**

School of Medicine, FIN-33014 University of Tampere, Finland

**Ciaran Kelly,**

Division of Gastroenterology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, 02215, USA

**Jonathan N Leonard,**

Department of Dermatology, Imperial College NHS Healthcare Trust, St Mary's Hospital, London W2 1NY, UK

**Knut E Lundin,**

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\*Correspondence and reprint requests: Daniel A Leffler, Division of Gastroenterology, Beth Israel Deaconess Medical Center, 330 Brookline Ave, Boston, MA, 02215, USA, dleffler@caregroup.harvard.edu.

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All authors declare that they have no conflicts of interest and therefore nothing to declare.

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### Contributors

CC and DAL initiated the study. JFL coordinated the project, conducted the web survey on coeliac disease definitions, and wrote the first draft of the paper. All authors contributed to the literature searches, contributed to the writing of the manuscript, and approved the final version of the manuscript.

Dept of Gastroenterology and Centre for Immune Regulation, Oslo University Hospital, 0027 Oslo, Norway

**Joseph A Murray,**  
Mayo Clinic, Rochester, MN, USA

**David S Sanders,**  
Gastroenterology and Liver Unit, Royal Hallamshire Hospital & University of Sheffield, Sheffield, 2JF UK

**Marjorie M Walker,**  
Centre for Pathology, Faculty of Medicine, Imperial College, St Mary's Hospital, London W2 1NY, UK

**Fabiana Zingone,** and  
Department of Clinical and Experimental Medicine, Federico II University of Naples, Naples, 80131, Italy

**Carolina Ciacci**  
Chair of Gastroenterology, University of Salerno, Salerno, 84084 Italy

## Abstract

**Background**—The literature suggests a lack of consensus on the use of terms related to coeliac disease (CD) and gluten.

**Methods**—A multi-disciplinary task force of 16 physicians from 7 countries used the electronic database PubMed to review the literature with regards to CD-related terms up to January 2011. Teams of physicians then suggested a definition for each term, followed by feedback of these definitions through a web survey on definitions, discussions during a meeting in Oslo, and phone conferences. We evaluated the following terms (in alphabetical order): Coeliac disease and the following descriptors of CD: asymptomatic, atypical, classical, latent, non-classical, overt, paediatric classical, potential, refractory, silent, subclinical, symptomatic, typical, CD serology, CD autoimmunity, genetically at risk of CD, dermatitis herpetiformis, gluten, gluten ataxia, gluten intolerance, gluten sensitivity, and gliadin-specific antibodies.

**Results**—CD was defined as “*a chronic small intestinal immune-mediated enteropathy precipitated by exposure to dietary gluten in genetically predisposed individuals*”. Classical CD was defined as “*CD presenting with signs and symptoms of malabsorption. Diarrhoea, steatorrhoea, weight loss or growth failure is required.*” We suggest that “gluten-related disorders” is the umbrella term for all diseases triggered by gluten and that the term gluten intolerance is not to be used. Other definitions are presented in the paper.

**Conclusion**—This paper presents the Oslo definitions for CD-related terms.

## Keywords

adult; autoimmunity; child; coeliac; gluten; sensitivity; intolerance

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## BACKGROUND

Coeliac disease (CD) is a chronic small intestinal immune-mediated enteropathy precipitated by exposure to dietary gluten in genetically predisposed individuals. Although symptoms and signs of CD have been recognised for more than 100 years, it was in the 1940s that the Dutch paediatrician Dicke established a link between the protein component of wheat (gluten) exposure and CD.<sup>1</sup> CD and related diseases are now common chronic diseases in children and adults, and increased diagnosis has led to proliferation of research activities.

As with many other chronic conditions, the boundaries of CD are not always clear, with the consequence that there is considerable confusion and a lack of consensus regarding diagnostic criteria of CD and related conditions.

The first consensus definition of CD was published in *Acta Paediatrica* in 1970.<sup>2</sup> This publication defined CD as a permanent condition of gluten intolerance with mucosal flattening that (a) reversed on a gluten-free diet (GFD) and (b) then relapsed on re-introduction of gluten. Although the definition of CD has undergone minor changes since 1970,<sup>3,4</sup> consensus definitions have been restricted to CD. However, the scientific community has come to recognise that there is a spectrum of disorders related to gluten ingestion.

Due to a lack of common definitions for the spectrum of terms and disorders related to CD, a multi-disciplinary task force of 16 physicians from 7 countries with particular expertise in diagnosis and treatment of CD proposes the following definitions for the variety of vague and often confusing terms currently in use in the literature. These definitions are based on thorough literature reviews (Table 1), a discussion in Oslo at the 14<sup>th</sup> International Coeliac Disease Symposium in June 2011, and agreement on consensus statements by web survey and phone conferences. We refer to our definitions as the “Oslo Definitions”.

The purpose of our recommended definitions is to create a foundation for both clinical management and research. Clear definitions will allow for more efficient and generalizable advances in CD research concerning aetiology, incidence, prevalence, complications, and treatment of patients with CD and other gluten-related disorders.

## METHODS

### Task force constitution

Members of this collaborative effort were invited by DAL and CC. The constitution of the group reflects the wide variety of disciplines to which CD may present in practice: gastroenterology, histopathology, paediatrics, neurology, and dermatology. Members of the task force originated from Sweden, US, Argentina, Italy, UK, Finland and Norway. Four of the five physicians from the US had trained elsewhere (two in Ireland, one in Australia and one in Italy).

### Literature review

Teams of 3–4 physicians were assigned 1–4 CD-related terms. Each team first carried out a literature search (Table 1). We searched the entire electronic database PubMed up to January 2011 using the terms of this review as key words. These included: *Coeliac disease* and these descriptors of CD: *asymptomatic, atypical, classical, latent, non-classical, overt, paediatric classical, potential, refractory, silent, subclinical, symptomatic, typical, CD serology, CD autoimmunity, genetically at risk of CD, dermatitis herpetiformis, gluten, gluten ataxia, gluten intolerance, gluten sensitivity, and gliadin-specific antibodies*.

We restricted most of our review to original papers and reviews. Most papers had been published after 1990. The teams then suggested definitions for each term.

### Web survey

We then constructed a web survey from which all suggested definitions were listed and subjected to peer review (Appendix).

Comments and feedback from the web survey were taken into account when constructing a second set of definitions.

## Discussions and phone meetings

The revised definitions and appending comments were then discussed in Oslo at the 14<sup>th</sup> international CD symposium in June 2011. This discussion was followed by two phone conferences in which the remaining definitions were discussed until consensus was achieved. We did not grade the evidence underlying each definition because that was not the purpose of our task force and this review did not deal with clinical management. For the convenience of the readers, each definition is followed by a short literature review of each term. Two terms were added after the initial web survey and the meeting in Oslo: *Dermatitis herpetiformis* and *CD autoimmunity* were discussed through email.

## RESULTS

### Coeliac disease

**A chronic small intestinal immune-mediated enteropathy precipitated by exposure to dietary gluten in genetically predisposed individuals**—CD is triggered by the ingestion of gluten (definition below), the protein component of wheat, rye, barley, but not oats.<sup>5, 6</sup> Such exposure results in a variable degree of intestinal damage.<sup>7</sup> In most patients with CD, the enteropathy will reverse on a GFD.<sup>2–4</sup> According to the suggested definition, CD is a chronic disease, but as the discussion of the terms potential CD and latent CD will show, there are reports of transient CD.<sup>8</sup>

Although CD is the most common cause of enteropathy in the western world and enteropathy is a prerequisite for CD, it should be noted that other diseases may cause small intestinal inflammation but do not qualify as CD.<sup>9</sup> Typically, the inflammation in CD includes an increased intraepithelial lymphocyte count, most often >25/100 cells.<sup>9, 10</sup> Another feature of CD is that it incorporates an adaptive T-cell-mediated response (to gluten) and that it occurs in DQ2-DQ8-positive individuals.<sup>11, 12</sup> Increasingly, the presence of specific endomysial antibodies (EMA, also called AEA), anti-tissue transglutaminase antibodies (TTG, a-tTG, TTA), and/or deamidated antigliadin antibodies (DGP) plays an important role in the serological work-up for CD. These antibodies strongly support the diagnosis of CD, but by themselves are not confirmatory.

To confirm a diagnosis of CD biopsies of the duodenum must be taken when patients are on a gluten-containing diet. Consensus states 4–6 biopsies are necessary for diagnosis,<sup>13</sup> including from the duodenal bulb.<sup>14, 15</sup>

Three histological classifications of CD are used: Marsh,<sup>7</sup> Marsh–Oberhuber<sup>16</sup> and Corazza<sup>10</sup>. A comparison of these classifications is shown in Table 2.

Historically, CD has been equivalent to *sprue*, *coeliac sprue*, *gluten-sensitive enteropathy*, and *gluten intolerance*. In the past the terms *non-tropical sprue* and *idiopathic steatorrhoea* were used.<sup>17, 18</sup> None of these terms are currently recommended.

### Gluten

**Gluten is the commonly used term for the complex of water insoluble proteins from wheat, rye and barley that are harmful to coeliac disease patients**—The major seed proteins in cereals are the alcohol soluble prolamins, a complex group of alcohol-soluble polypeptides that make up about half of the protein in the mature grain. The term gluten indicates a broad group of prolamins (gliadins and glutenins) found in wheat. Other prolamins showing similar immunogenic properties are found also in rye (secalins), barley (hordeins), and other closely related grains.<sup>13, 19</sup> The major prolamins of the more distantly related maize (zeins) seem to have evolved independently and show no harmful

effects in coeliac patients. Oats also have been shown to be non-immunogenic in most individuals with CD.<sup>20</sup> A gluten-free diet usually indicates a diet free from wheat, rye, barley, triticale, kamut and spelt.

Gluten is poorly digested in the human intestine with or without CD. Gluten peptides cross intact into the submucosa of the small intestine. In the submucosa of the small intestine the human enzyme transglutaminase 2 (TG2) also referred to as tissue transglutaminase (tTG) deamidates gluten peptides, which allows for high-affinity binding to HLA DQ2 and HLA DQ8 molecules, subsequently triggering an inflammatory reaction in patients with CD.<sup>12</sup>

Gluten-content in food is regulated by the Codex Alimentarius (<http://www.codexalimentarius.net>). This codex (CODEX STAN 118 – 1979 revised in 2008) states that gluten-free foods are those foods or ingredients naturally free of gluten, in which the measured gluten level is 20 mg/kg in total, or processed to <100 mg/kg. By the current Codex, foods meeting this criteria may be labelled as a ‘gluten-free food’.

### Asymptomatic CD

**CD not accompanied by symptoms even in response to direct questioning at initial diagnosis**—Individuals with asymptomatic CD do not manifest any symptoms commonly associated with CD and have no symptoms that respond to gluten withdrawal, even in response to direct questioning. These patients are often diagnosed through testing of populations enrolled in screening programs or in case-finding strategies for detecting CD in patients with disorders that are associated with a high risk for CD<sup>21–33</sup> Many of these patients suffer from decreased quality of life. Sometimes minor symptoms (e.g., fatigue) are only recognized after the introduction of a GFD,<sup>34</sup> such patients do not suffer from true asymptomatic CD and should be re-classified as having subclinical CD.

### Typical CD

Historically, typical CD has denoted a gluten-induced enteropathy presenting with signs or symptoms of malabsorption/global malabsorption (such as diarrhoea or malnutrition) or a malabsorption syndrome (indicated by weight loss, steatorrhoea, and oedema secondary to hypoalbuminemia). The above use is questionable in that the clinical presentation of CD has changed over time,<sup>35–37</sup> and the word “typical” implies that this form is the most frequently encountered form of CD. In contrast, many current patients have symptoms such as anaemia,<sup>38–40</sup> fatigue,<sup>41, 42</sup> and abdominal pain<sup>43</sup>.

We therefore discourage the use of the term Typical CD.

### Atypical CD

Atypical CD can only be used in reference to typical CD. Historically, atypical CD has been used to describe patients with gluten-induced enteropathy that have no weight loss but present with any of the following symptoms/signs: (a) gastrointestinal (GI) symptoms<sup>44</sup> including symptoms suggestive of irritable bowel syndrome,<sup>45, 46</sup> and liver dysfunction<sup>47, 48</sup>; (b) extraintestinal manifestations, such as metabolic disease/symptoms (failure to thrive, thyroid dysfunction (hypo/hyper)<sup>49, 50</sup>; (c) neurologic findings,<sup>51–53</sup> including depression<sup>54</sup> and gluten ataxia<sup>55</sup>; (d) reproductive disease<sup>56–58</sup> including abnormalities in menarche and menopause<sup>58, 59</sup>; (e) oral/cutaneous disease<sup>60–64</sup> including dermatitis herpetiformis (DH)<sup>65</sup>; and (f) skeletal findings<sup>66</sup>. Atypical CD has also been used to denote patients with a gluten-induced enteropathy and significant nutritional deficiencies (such as iron deficiency). We argue that the term atypical CD should not be used. Some patients previously described as having atypical CD may fulfil the requirements for non-classical CD (below).

## Classical CD

**CD presenting with signs and symptoms of malabsorption. Diarrhoea, steatorrhoea, weight loss or growth failure is required**—Classical and typical CD have traditionally been similar concepts defining the presence of a gluten-induced enteropathy presenting with diarrhoea, malnutrition, or a malabsorption syndrome (indicated by weight loss, steatorrhoea, and oedema secondary to hypoalbuminemia).<sup>7, 67–74</sup> While recognizing that these symptoms are not specific to CD, we encourage the use of classical CD, as defined above, because the term “classical” does not imply that this type of CD is more common than CD without clinical malabsorption. Examples of classical CD are patients with diarrhoea and weight loss but also patients with weight loss and anaemia.

Paediatric classical CD is the paediatric equivalent of classical CD. These children are often characterised by failure to thrive, diarrhoea, muscle wasting, poor appetite, and abdominal distension.<sup>75–79</sup> Many children with classical CD and malabsorption also show signs of emotional distress (“change of mood”) and lethargy.<sup>72</sup>

## Non-classical CD

**CD presenting without signs and symptoms of malabsorption**—In non-classical CD the patient does not suffer from malabsorption (e.g., a patient with constipation and abdominal pain but no malabsorption). Patients with monosymptomatic disease (other than diarrhoea/steatorrhoea) usually suffer from non-classical CD.

## Silent CD

Silent CD is equivalent to asymptomatic CD. We discourage the use of the term silent CD.

## Subclinical CD

**CD that is below the threshold of clinical detection**—The term subclinical has often been used to denote silent CD<sup>80–82</sup> or CD patients with extraintestinal symptoms (and no GI symptoms)<sup>83</sup>. The term has also been used for CD patients having *clinical or laboratory signs* (iron deficiency anaemia, abnormalities in liver function tests, enamel defects, incidental endoscopic features, osteoporosis, etc.) but *no symptoms*.<sup>84</sup>

As understanding of CD has advanced, new disease associations have been regularly found and populations tested for CD have changed in response. For this reason what is ‘subclinical’ has changed over time. In order to provide a stable definition, we specified subclinical CD to be disease that is below the threshold of clinical detection without signs or symptoms sufficient to trigger CD testing in routine practice.

## Symptomatic CD

**CD characterized by clinically evident gastrointestinal and/or extraintestinal symptoms attributable to gluten intake**—The clinical manifestations of CD vary from none (asymptomatic CD) to a wide spectrum of symptoms. The vast majority of authors describing symptomatic CD do not distinguish between CD with GI and CD with extraintestinal symptoms.<sup>85–98</sup>

What was previously called overt CD should be considered part of symptomatic CD.

## Overt CD

Overt CD has most often been characterised by clinically evident gluten-related symptoms, either GI (dyspepsia, diarrhoea, and bloating) or extraintestinal (neurological symptoms and

fatigue).<sup>99, 100</sup> We recommend that the term overt CD should not be used, and that symptomatic CD is preferred.

## Refractory CD

**Persistent or recurrent malabsorptive symptoms and signs with villous atrophy despite a strict gluten free diet for more than 12 months**—Although definitions of refractory CD (RCD) differ slightly,<sup>101–118</sup> most expert opinion based definitions include persistence or recurrence of malabsorptive symptoms and signs (e.g., diarrhoea, abdominal pain, involuntary loss of weight, low haemoglobin, and hypoalbuminemia) associated with persistent or recurrent villous atrophy (VA) despite a strict GFD for more than 12 months (or severe persistent symptoms independently of the duration of GFD) in the absence of other causes of VA or malignant complications<sup>119</sup> and after the confirmation of the initial diagnosis of CD.

Generally, most patients have negative EMA and TTG antibodies at the time of RCD diagnosis, but the presence of persisting elevated titres of circulating EMA and/or TTG antibodies does not necessarily rule out RCD, though this should lead to questions about dietary adherence. In all cases, a careful dietary interview should be performed to exclude gluten exposure before diagnosing RCD.<sup>120</sup> Not all dietary non-responsive CD is refractory CD.<sup>121–123</sup>

RCD is divided into two categories:<sup>111, 115</sup> *type I*, in which a normal intraepithelial lymphocyte (IEL) phenotype is found, and *type II*, in which there is a clonal expansion of an aberrant IEL population. The abnormal phenotype is supported by: loss of normal surface markers CD3, CD4, and CD8 with preserved expression of intracytoplasmic CD3 (CD3e) in >50% of intraepithelial lymphocytes as evaluated by immunohistochemistry or >20% as determined by flow cytometry, and by detection of clonal rearrangement of T-cell receptor chains ( $\gamma$  or  $\delta$ ) by polymerase chain reaction.<sup>104, 107, 108, 115, 116</sup>

## Latent CD

The literature reveals at least five definitions of latent CD: (1) Positive CD serology in patients with normal mucosa or absence of VA<sup>124–129</sup> and (2) normal mucosa in patients who are on a gluten-containing diet, but have had an *earlier* or will have a *later* flat mucosa when they eat gluten.<sup>130–134</sup> To some physicians latent CD is (3) simply equivalent to undiagnosed CD,<sup>135, 136</sup> (4) whereas others refer to latent CD as CD preceded by another autoimmune disease (e.g., type 1 diabetes or thyroid disease). Finally, (5) latent CD is sometimes used to denote normal mucosa with non-serological abnormalities, such as an increased number of gamma-delta cells or increased mucosal permeability.<sup>137</sup> Considering that the terms potential CD and latent CD have often been used interchangeably, resulting in confusion, we discourage the use of latent CD.

## Potential CD

**Individuals with a normal small intestinal mucosa who are at increased risk of developing CD as indicated by positive CD serology**—Potential CD is also often used with different meanings. For some, potential CD means that the patient has an increased number of IELs in the villi<sup>138</sup> or increased expression of gamma-delta cells.<sup>139</sup> To others potential CD describes individuals with normal mucosa but positive CD serology.<sup>140, 141</sup> Adding to this is the suggestion by Ferguson *et al* that all first-degree relatives to patients with CD have potential CD.<sup>142</sup>

We recommend that the term potential CD be used for individuals with normal small intestinal mucosa who are at increased risk of developing CD as indicated by positive CD



serology. A difficulty in the definition of this group is variability in the adequacy of the biopsies that were taken to exclude the diagnosis of active CD, especially with the current knowledge that at least four biopsies need to be taken<sup>143</sup> and the bulb may be the only location of VA.<sup>15</sup>

### Coeliac disease autoimmunity

**Increased TTG or EMA on at least two occasions when status of the biopsy is not known. If the biopsy is positive, then this is CD, if the biopsy is negative than this is potential CD**—The term “coeliac disease autoimmunity” or “coeliac autoimmunity” has been used to describe: individuals with positive TTG<sup>144–147</sup>, positive EMA<sup>148</sup>, positive EMA *with* positive/borderline TTG<sup>149</sup>, positive TTG on at least *two occasions*<sup>150</sup>, and positive TTG on 2 occasions or a positive small bowel biopsy after only a single positive TTG<sup>151</sup>.

We defined coeliac disease autoimmunity as positive TTG or EMA on at least two occasions. In a clinical setting this will lead to a small intestinal biopsy, and patients can then be classified as either CD (positive biopsy) or potential CD (negative biopsy), but in a research setting there are circumstances where small intestinal biopsy has not been performed. The term coeliac disease autoimmunity should then be used. When TTG or EMA has only been tested on one occasion, it is preferable to refer to patients as TTG+ or EMA+.

### Genetically at risk of CD

**Family members of CD patients that test positive for HLA DQ2 and/or DQ8**—CD is a multi-factorial condition with unparalleled evidence of the pivotal role of human leukocyte antigen (HLA)-DQA1\*05-DQB1\*02 (DQ2) and DQA1\*03-DQB1\*0302 (DQ8) in disease predisposition.<sup>152, 153</sup> Both DQ2 and DQ8 are major risk factors carried by almost all CD patients. Interestingly, when carried in *trans* on DR5/DR7 (i.e. *DQA1\*05-DQB1\*0301/DQA1\*0201-DQB1\*02*) or DR3/DR7 (i.e. *DQA1\*05-DQB1\*02/DQA1\*0201-DQB1\*02*) genotypes, the risk of CD in Southern Europeans is higher than when the alleles are carried in *cis* on DR3 (i.e. *DQA1\*05-DQB1\*02*) alone, suggesting that additional factors in the region may be influencing disease propensity.

Non-HLA genes together contribute more to genetic susceptibility (approximately 65%) than do the HLA genes (the remaining 35%), but the contribution from each single, predisposing non-HLA gene appears to be modest.<sup>154</sup>

At the moment, the concept of genetically at risk for CD should be limited to family members (of CD patients) who test positive for HLA-DQ2 or HLA-DQ8, with the understanding that the risk varies between 2% and 20%, depending on the degree of the relative with CD and the number of copies of HLA-DQ2 genes. However, any individual who harbours these genes are at risk of developing CD.

### Gluten intolerance

The term gluten intolerance has been used both as a synonym of CD and to indicate that a patient experiences a clinical improvement after starting a GFD, even when he/she does not have CD.<sup>8, 76, 122, 155–166</sup> However, we believe the term gluten intolerance is non specific and carries inherent weaknesses and contradictions. Although gluten intolerance could be a consequence of poor digestion, it could also be the effect of some lectin-like properties of gluten or foods generated from gluten that cause GI upset. Another problem is that gluten intolerance may not truly reflect intolerance to gluten but to other wheat components.<sup>156</sup> Because of these contradictions, we recommend that the term gluten intolerance should not be used and that gluten-related disorders be used instead.

## Gluten-related disorders

**Gluten-related disorders is a term used to describe all conditions related to gluten**—We recommend that the term gluten-related disorders be used to describe all conditions related to gluten. This may include such disorders as gluten ataxia, dermatitis herpetiformis (DH), non-coeliac gluten sensitivity, and CD.<sup>115, 167, 168</sup>

## Gluten sensitivity

In some papers the term gluten sensitivity is used synonymously with CD.<sup>7</sup> Other papers used the concept of gluten sensitivity as an umbrella term to include CD and other conditions related to gluten ingestion, such as DH,<sup>169</sup> gluten ataxia,<sup>170</sup> and non-coeliac gluten sensitivity.<sup>156</sup> Most recently,<sup>157, 171–174</sup> several authors employed the term gluten sensitivity to describe a condition in which symptoms are triggered by gluten ingestion, in the absence of TTG or EMA antibodies and enteropathy, with variable HLA status as well as variable AGA presence. It is important to distinguish CD from less well characterized diseases related to gluten ingestion. We therefore recommend that the term gluten sensitivity should not be used and that non-coeliac gluten sensitivity be used instead.

## Non-coeliac gluten sensitivity

**One or more of a variety of immunological, morphological, or symptomatic manifestations that are precipitated by the ingestion of gluten in individuals in whom CD has been excluded**—Non-coeliac gluten sensitivity (NCGS) is a condition in which gluten ingestion leads to morphological or symptomatic manifestations despite the absence of CD.<sup>172–176</sup> As opposed to CD, NCGS may show signs of an activated innate immune response but without the enteropathy, elevations in tTG, EMA or DGP antibodies, and increased mucosal permeability characteristic of CD.<sup>173</sup> Recently, Biesiekierski *et al* in a double-blind randomized trial showed that patients with NCGS truly develop symptoms when eating gluten.<sup>156</sup> It is unclear at this time what components of grains trigger symptoms in individuals with NCGS and whether some populations of NCGS patients have subtle small intestinal morphological changes. While there currently is no standard diagnostic approach to NCGS, systematic evaluation should be conducted including exclusion of CD and other inflammatory disorders.

## Gliadin-specific antibodies

**Anti-gliadin (AGA) antibodies of both IgA and IgG subclass recognizing the gliadin moiety of wheat. Antibodies recognizing native gluten are now rarely used for diagnostic purposes because they lack general specificity. Antibodies recognizing deamidated gliadin peptides demonstrate high specificity and sensitivity. They can also be used for measurement of gluten in food-stuffs**—Use of the term gliadin specific antibodies generally refers to antibodies directed against the gliadin moiety of wheat prolamins. Four aspects of these antibodies are relevant to the spectrum of gluten-induced disease (I–IV).

(I) *Diagnostic value.* After introduction in the 1980s IgA antibodies against wheat gliadin (AGA, anti-gliadin antibodies) served as the best serological test for CD for some years.<sup>177, 178</sup> However, its low positive predictive value<sup>179</sup> meant that it has since been abandoned for the investigation of CD,<sup>13, 179</sup> outside of children below the age of 18 months, where IgA AGA seems to have high sensitivity.<sup>180</sup> Recently assays for IgA and IgG antibodies against deamidated gliadin peptides (DGP) have been introduced<sup>181</sup> and perform similarly to TTG-based tests.<sup>179</sup> (II) Elevated levels of AGA have also been used for the investigation of possible *increased gut permeability* but this use in clinical practice lacks a strong scientific background. (III) AGAs are also relevant to gluten-induced disorders

*beyond the classical enteropathy.* The most well-known example is that for gluten ataxia. Patients with this disorder may have CD or only elevated levels of IgA or IgG AGAs.<sup>55</sup> (See Gluten Ataxia) (IV) Gluten-specific antibodies have a clear role in the food industry in that they are indispensable for *measurement of gluten in foods*. More recently, an assay using a monoclonal antibody recognising a major coeliac toxic epitope has been developed.<sup>182</sup> This assay is now the preferred method for gluten analysis in food.<sup>183</sup>

### Coeliac disease serology

**“Coeliac disease serology” is a term that includes endomysium, transglutaminase, deamidated gliadin antibodies, and in small children also gliadin antibodies for the assessment of CD**—Since the introduction of AGA, antibodies have become an important means to diagnose CD. Serological testing has been used routinely in the investigation of CD since the 1980s. Whereas AGA tests were common in the 1980s and 1990s,<sup>184</sup> laboratories have since gradually shifted to EMA and TTG tests.<sup>185–187</sup> In most patient groups with suspected CD, EMA, and TTG tests have a higher sensitivity and specificity than the AGA test.<sup>188</sup> We defined CD serology as an all encompassing term that includes all available tests which have been shown in clinical studies to be sensitive for assessment of CD. Accordingly, we discourage the use of the term CD serology in that it is preferable to specify the antibody tests used because sensitivity and specificity differ substantially. We have nevertheless suggested a definition of this term, since it is extensively used.

### Gluten ataxia

**Idiopathic sporadic ataxia and positive serum antigliadin antibodies even in the absence of duodenal enteropathy**—Gluten ataxia is one of a number of neurological manifestations attributed to CD. Defining criteria for gluten ataxia<sup>170, 189, 190</sup> include otherwise idiopathic sporadic ataxia in association with positive AGA with or without enteropathy on duodenal biopsy. Most reports (22/35 reports) after 1998 have used the same definition, i.e. idiopathic sporadic ataxia with positive AGA (IgG or IgA, or both). However, a number of reports refer to patients with established CD (13/35 reports) without always providing serological information on these patients other than stating that the patient had CD (taken to imply the presence of enteropathy).<sup>170, 191–199</sup>

One report examined the presence of IgA deposits on duodenal biopsies and found that all 10 patients with gluten ataxia (without enteropathy) had such deposits.<sup>195</sup> One study has identified a novel transglutaminase (TTG6) as a potential new serological marker for gluten ataxia,<sup>192</sup> but currently the most appropriate definition for gluten ataxia remains that of idiopathic sporadic ataxia with positive AGA.

### Dermatitis herpetiformis (DH)

**DH is a cutaneous manifestation of small intestinal immune-mediated enteropathy precipitated by exposure to dietary gluten. It is characterized by herpetiform clusters of pruritic urticated papules and vesicles on the skin, especially on the elbows, buttocks, and knees, and IgA deposits in the dermal papillae. DH responds to a GFD**—DH is characterized by the presence of IgA deposits in the skin<sup>200–202</sup> DH is strongly linked to an immune mediated enteropathy precipitated by gluten,<sup>65, 203–205</sup> and responds to a GFD.<sup>206–209</sup> A study from the USA in 1992 documented a prevalence of 11.2 per 100,000 people and an incidence of 0.98 per 100,000 people per year,<sup>210</sup> these rates are comparable to earlier studies of prevalence of DH in Northern Europe.<sup>205</sup>

Villous atrophy will be revealed by a single intestinal biopsy in two thirds of patients, and by multiple biopsies in 95%. The enteropathy is variable in severity, but even in the presence of normal villous architecture, elevated levels of  $\gamma\delta$  T lymphocytes in the intestinal mucosa, elevated intraepithelial lymphocyte counts and induction of villous atrophy are noted on gluten challenge, and these patients are very likely to reflect the entire spectrum of histological and clinical CD in adults.<sup>65, 211</sup> The association with HLA is the same as in CD, 90% of patients have HLA DQ2 and, almost all the remainder, HLA DQ8.<sup>212</sup> The skin lesions clear with gluten withdrawal but may also require treatment by the neutrophil inhibitor Dapsone.<sup>207, 208, 213</sup> In the long term, adherence to a strict GFD shows 47% of patients can stop drug treatment completely; however 15% will not be able to reduce the dose of Dapsone.<sup>214</sup>

## DISCUSSION

This review was done on the basis of PubMed literature searches and expert meetings. We aimed to define key concepts relevant to CD and related disorders. The character of the current paper implies that we did not pool any data or use any statistical tools. Instead, we assembled an international team of recognized experts in CD research, discussed definitions and tried to reach a consensus. This approach is similar to that of previous papers on definitions in CD.<sup>2-4</sup> As opposed to previous studies,<sup>2-4</sup> however, we did not limit ourselves to “CD only” but defined a large number of concepts. In addition, we give guidance to the scientific and clinical community as to which terms should be used and which are to be abandoned.

Overall, we evaluated more than 300 papers in detail and all authors participated in the discussion leading to consensus definitions. We tried to avoid cumbersome definitions and have mostly avoided the inclusion of specific techniques, antibodies, and measurements/units in these definitions. Cumbersome definitions are rarely used in practice and because of the progress in the CD research field, statements on specific tests may rapidly become obsolete.

Our research team was multi-disciplinary and was composed of specialists from gastroenterology, pathology, paediatrics, neurology, and dermatology. We hope that our definitions will be acceptable to all specialties dealing with CD and gluten-related disorders and anticipate that they will facilitate both research and clinical management of patients with these disorders.

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## Abbreviations used in this article

<b>AGA</b>	anti-gliadin antibodies
<b>CD</b>	Coeliac disease

<b>EMA</b>	Endomysial antibodies
<b>DH</b>	Dermatitis herpetiformis
<b>GFD</b>	Gluten-free diet
<b>IEL</b>	Intraepithelial lymphocytes
<b>TTG</b>	Tissue transglutaminase antibodies

## References

1. van Berge-Henegouwen GP, Mulder CJ. Pioneer in the gluten free diet: Willem-Karel Dicke 1905–1962, over 50 years of gluten free diet. *Gut*. 1993; 34:1473–5. [PubMed: 8244125]
2. Meeuwisse GW. Round table discussion. Diagnostic criteria in coeliac disease. *Acta Paediatr*. 1970; 59:461–63.
3. McNeish AS, Harms HK, Rey J, et al. The diagnosis of coeliac disease. A commentary on the current practices of members of the European Society for Paediatric Gastroenterology and Nutrition (ESPGAN). *Arch Dis Child*. 1979; 54:783–6. [PubMed: 507902]
4. Revised criteria for diagnosis of coeliac disease. Report of Working Group of European Society of Paediatric Gastroenterology and Nutrition. *Arch Dis Child*. 1990; 65:909–11. [PubMed: 2205160]
5. Janatuinen EK, Pikkarainen PH, Kemppainen TA, et al. A comparison of diets with and without oats in adults with celiac disease [see comments]. *N Engl J Med*. 1995; 333:1033–7. [PubMed: 7675045]
6. Vader LW, de Ru A, van der Wal Y, et al. Specificity of tissue transglutaminase explains cereal toxicity in celiac disease. *J Exp Med*. 2002; 195:643–9. [PubMed: 11877487]
7. Marsh MN. Gluten, major histocompatibility complex, and the small intestine. A molecular and immunobiologic approach to the spectrum of gluten sensitivity ('celiac sprue'). *Gastroenterology*. 1992; 102:330–54. [PubMed: 1727768]
8. Walker-Smith JA. Transient gluten intolerance. *Arch Dis Child*. 1996; 74:183–4. [PubMed: 8660090]
9. Walker MM, Murray JA, Ronkainen J, et al. Detection of Celiac Disease and Lymphocytic Enteropathy by Parallel Serology and Histopathology in a Population-Based Study. *Gastroenterology*. 2010; 139:112–9. [PubMed: 20398668]
10. Corazza GR, Villanacci V, Zambelli C, et al. Comparison of the interobserver reproducibility with different histologic criteria used in celiac disease. *Clin Gastroenterol Hepatol*. 2007; 5:838–43. [PubMed: 17544877]
11. Lundin KE, Scott H, Hansen T, et al. Gliadin-specific, HLA-DQ(alpha 1\*0501, beta 1\*0201) restricted T cells isolated from the small intestinal mucosa of celiac disease patients. *J Exp Med*. 1993; 178:187–96. [PubMed: 8315377]
12. Molberg O, McAdam SN, Korner R, et al. Tissue transglutaminase selectively modifies gliadin peptides that are recognized by gut-derived T cells in celiac disease [see comments] [published erratum appears in *Nat Med* 1998 Aug;4(8):974]. *Nat Med*. 1998; 4:713–7. [PubMed: 9623982]
13. Rostom A, Murray JA, Kagnoff MF. American Gastroenterological Association (AGA) Institute technical review on the diagnosis and management of celiac disease. *Gastroenterology*. 2006; 131:1981–2002. [PubMed: 17087937]
14. Hopper AD, Cross SS, Sanders DS. Patchy villous atrophy in adult patients with suspected gluten-sensitive enteropathy: is a multiple duodenal biopsy strategy appropriate? *Endoscopy*. 2008; 40:219–24. [PubMed: 18058655]
15. Gonzalez S, Gupta A, Cheng J, et al. Prospective study of the role of duodenal bulb biopsies in the diagnosis of celiac disease. *Gastrointest Endosc*. 2010; 72:758–65. [PubMed: 20883853]
16. Oberhuber G, Granditsch G, Vogelsang H. The histopathology of coeliac disease: time for a standardized report scheme for pathologists. *Eur J Gastroenterol Hepatol*. 1999; 11:1185–94. [PubMed: 10524652]
17. AGA Institute Medical Position Statement on the Diagnosis and Management of Celiac Disease. *Gastroenterology*. 2006; 131:1977–80. [PubMed: 17087935]

18. Crowe SE. In the clinic. Celiac disease. *Ann Intern Med.* 2011; 154:ITC5-1–ITC5-15. quiz ITC5-16. [PubMed: 21536935]
19. Platt SG, Kasarda DD. Separation and characterization of -gliadin fractions. *Biochim Biophys Acta.* 1971; 243:407–15. [PubMed: 5129586]
20. Koskinen O, Villanen M, Korponay-Szabo I, et al. Oats do not induce systemic or mucosal autoantibody response in children with coeliac disease. *J Pediatr Gastroenterol Nutr.* 2009; 48:559–65. [PubMed: 19412007]
21. Katz KD, Rashtak S, Lahr BD, et al. Screening for celiac disease in a north american population: sequential serology and gastrointestinal symptoms. *Am J Gastroenterol.* 2011; 106:1333–9. [PubMed: 21364545]
22. Tursi A, Elisei W, Giorgetti GM, et al. Prevalence of celiac disease and symptoms in relatives of patients with celiac disease. *Eur Rev Med Pharmacol Sci.* 2010; 14:567–72. [PubMed: 20712266]
23. Freeman HJ. Risk factors in familial forms of celiac disease. *World J Gastroenterol.* 2010; 16:1828–31. [PubMed: 20397258]
24. Legroux-Gerot I, Leloire O, Blanckaert F, et al. Screening for celiac disease in patients with osteoporosis. *Joint Bone Spine.* 2009; 76:162–5. [PubMed: 19179099]
25. Barker JM, Liu E. Celiac disease: pathophysiology, clinical manifestations, and associated autoimmune conditions. *Adv Pediatr.* 2008; 55:349–65. [PubMed: 19048738]
26. Alzahrani AS, Al Sheef M. Severe primary hyperparathyroidism masked by asymptomatic celiac disease. *Endocr Pract.* 2008; 14:347–50. [PubMed: 18463042]
27. Ch'ng CL, Jones MK, Kingham JG. Celiac disease and autoimmune thyroid disease. *Clin Med Res.* 2007; 5:184–92. [PubMed: 18056028]
28. Swigonski NL, Kuhlenschmidt HL, Bull MJ, et al. Screening for celiac disease in asymptomatic children with Down syndrome: cost-effectiveness of preventing lymphoma. *Pediatrics.* 2006; 118:594–602. [PubMed: 16882812]
29. Dube C, Rostom A, Sy R, et al. The prevalence of celiac disease in average-risk and at-risk Western European populations: a systematic review. *Gastroenterology.* 2005; 128:S57–67. [PubMed: 15825128]
30. Kumar V, Rajadhyaksha M, Wortsman J. Celiac disease-associated autoimmune endocrinopathies. *Clin Diagn Lab Immunol.* 2001; 8:678–85. [PubMed: 11427410]
31. Hoffenberg EJ, Bao F, Eisenbarth GS, et al. Transglutaminase antibodies in children with a genetic risk for celiac disease. *J Pediatr.* 2000; 137:356–60. [PubMed: 10969260]
32. Lorini R, Scaramuzza A, Vitali L, et al. Clinical aspects of coeliac disease in children with insulin-dependent diabetes mellitus. *J Pediatr Endocrinol Metab.* 1996; 9 (Suppl 1):101–11. [PubMed: 8887160]
33. Stewart J. Asymptomatic coeliac disease in adults. *Ir Med J.* 1974; 67:415–6. [PubMed: 4412109]
34. Marine M, Fernandez-Banares F, Alsina M, et al. Impact of mass screening for gluten-sensitive enteropathy in working population. *World J Gastroenterol.* 2009; 15:1331–8. [PubMed: 19294762]
35. Maki M, Kallonen K, Lahdeaho ML, et al. Changing pattern of childhood coeliac disease in Finland. *Acta Paediatr Scand.* 1988; 77:408–12. [PubMed: 3389134]
36. Ludvigsson JF, Ansved P, Falth-Magnusson K, et al. Symptoms and Signs Have Changed in Swedish Children With Coeliac Disease. *J Pediatr Gastroenterol Nutr.* 2004; 38:181–86. [PubMed: 14734881]
37. Rampertab SD, Pooran N, Brar P, et al. Trends in the presentation of celiac disease. *Am J Med.* 2006; 119:355, e9–14. [PubMed: 16564784]
38. Corazza GR, Valentini RA, Andreani ML, et al. Subclinical coeliac disease is a frequent cause of iron-deficiency anaemia. *Scand J Gastroenterol.* 1995; 30:153–6. [PubMed: 7732338]
39. Hin H, Bird G, Fisher P, et al. Coeliac disease in primary care: case finding study. *Bmj.* 1999; 318:164–7. [PubMed: 9888912]
40. Unsworth DJ, Lock RJ, Harvey RF. Improving the diagnosis of coeliac disease in anaemic women. *Br J Haematol.* 2000; 111:898–901. [PubMed: 11122153]
41. Siniscalchi M, Iovino P, Tortora R, et al. Fatigue in adult coeliac disease. *Aliment Pharmacol Ther.* 2005; 22:489–94. [PubMed: 16128688]

42. Sanders DS, Evans KE, Hadjivassiliou M. Fatigue in primary care. Test for coeliac disease first? *BMJ*. 2010; 341:c5161. [PubMed: 21045029]
43. van der Windt DA, Jellema P, Mulder CJ, et al. Diagnostic testing for celiac disease among patients with abdominal symptoms: a systematic review. *JAMA*. 2010; 303:1738–46. [PubMed: 20442390]
44. Nachman F, Vazquez H, Gonzalez A, et al. Gastroesophageal reflux symptoms in patients with celiac disease and the effects of a gluten-free diet. *Clin Gastroenterol Hepatol*. 2011; 9:214–9. [PubMed: 20601132]
45. Sanders DS, Carter MJ, Hurlstone DP, et al. Association of adult coeliac disease with irritable bowel syndrome: a case-control study in patients fulfilling ROME II criteria referred to secondary care. *Lancet*. 2001; 358:1504–8. [PubMed: 11705563]
46. Ford AC, Chey WD, Talley NJ, et al. Yield of diagnostic tests for celiac disease in individuals with symptoms suggestive of irritable bowel syndrome: systematic review and meta-analysis. *Arch Intern Med*. 2009; 169:651–8. [PubMed: 19364994]
47. Volta U, De Franceschi L, Lari F, et al. Coeliac disease hidden by cryptogenic hypertransaminasaemia. *Lancet*. 1998; 352:26–9. [PubMed: 9800742]
48. Franzese A, Iannucci MP, Valerio G, et al. Atypical celiac disease presenting as obesity-related liver dysfunction. *J Pediatr Gastroenterol Nutr*. 2001; 33:329–32. [PubMed: 11593131]
49. Puri AS, Garg S, Monga R, et al. Spectrum of atypical celiac disease in North Indian children. *Indian Pediatr*. 2004; 41:822–7. [PubMed: 15347870]
50. Elfstrom P, Montgomery SM, Kampe O, et al. Risk of thyroid disease in individuals with celiac disease. *J Clin Endocrinol Metab*. 2008; 93:3915–21. [PubMed: 18611971]
51. Lionetti E, Francavilla R, Pavone P, et al. The neurology of coeliac disease in childhood: what is the evidence? A systematic review and meta-analysis. *Dev Med Child Neurol*. 2010; 52:700–7. [PubMed: 20345955]
52. Hadjivassiliou M, Grunewald RA, Kandler RH, et al. Neuropathy associated with gluten sensitivity. *J Neurol Neurosurg Psychiatry*. 2006; 77:1262–6. [PubMed: 16835287]
53. Ludvigsson JF, Olsson T, Ekblom A, et al. A population-based study of coeliac disease, neurodegenerative and neuroinflammatory diseases. *Aliment Pharmacol Ther*. 2007; 25:1317–27. [PubMed: 17509100]
54. Ciacci C, Iavarone A, Mazzacca G, et al. Depressive symptoms in adult coeliac disease. *Scand J Gastroenterol*. 1998; 33:247–50. [PubMed: 9548616]
55. Hadjivassiliou M, Sanders DS, Woodroffe N, et al. Gluten ataxia. *Cerebellum*. 2008; 7:494–8. [PubMed: 18787912]
56. Zugna D, Richiardi L, Akre O, et al. A nationwide population-based study to determine whether coeliac disease is associated with infertility. *Gut*. 2010; 59:1471–5. [PubMed: 20947882]
57. Ciacci C, Cirillo M, Auriemma G, et al. Celiac disease and pregnancy outcome. *Am J Gastroenterol*. 1996; 91:718–22. [PubMed: 8677936]
58. Santonicola A, Iovino P, Cappello C, et al. From menarche to menopause: the fertile life span of celiac women. *Menopause*. 2011
59. Martinelli D, Fortunato F, Tafuri S, et al. Reproductive life disorders in Italian celiac women. A case-control study. *BMC Gastroenterol*. 2010; 10:89. [PubMed: 20691041]
60. Corazza GR, Andreani ML, Ventura N, et al. Celiac disease and alopecia areata: report of a new association. *Gastroenterology*. 1995; 109:1333–7. [PubMed: 7557104]
61. Ferguson MM, Wray D, Carmichael HA, et al. Coeliac disease associated with recurrent aphthae. *Gut*. 1980; 21:223–6. [PubMed: 7399324]
62. Cheng J, Malahias T, Brar P, et al. The association between celiac disease, dental enamel defects, and aphthous ulcers in a United States cohort. *J Clin Gastroenterol*. 2010; 44:191–4. [PubMed: 19687752]
63. Ludvigsson JF, Lindelof B, Zingone F, et al. Psoriasis in a Nationwide Cohort Study of Patients with Celiac Disease. *J Invest Dermatol*. 2011
64. Pastore L, Lo Muzio L, Serpico R. Atrophic glossitis leading to the diagnosis of celiac disease. *N Engl J Med*. 2007; 356:2547. [PubMed: 17568041]

65. Zone JJ. Skin manifestations of celiac disease. *Gastroenterology*. 2005; 128:S87–91. [PubMed: 15825132]
66. Collin P, Korpela M, Hallstrom O, et al. Rheumatic complaints as a presenting symptom in patients with coeliac disease. *Scand J Rheumatol*. 1992; 21:20–3. [PubMed: 1570482]
67. Logan RF, Tucker G, Rifkind EA, et al. Changes in clinical features of coeliac disease in adults in Edinburgh and the Lothians 1960–79. *Br Med J (Clin Res Ed)*. 1983; 286:95–7.
68. Farrell RJ, Kelly CP. Diagnosis of celiac sprue. *Am J Gastroenterol*. 2001; 96:3237–46. [PubMed: 11774931]
69. Wahab PJ, Meijer JW, Goerres MS, et al. Coeliac disease: changing views on gluten-sensitive enteropathy. *Scand J Gastroenterol Suppl*. 2002;60–5. [PubMed: 12408506]
70. Lo W, Sano K, Lebowitz B, et al. Changing presentation of adult celiac disease. *Dig Dis Sci*. 2003; 48:395–8. [PubMed: 12643621]
71. Mulder CJ, Cellier C. Coeliac disease: changing views. *Best Pract Res Clin Gastroenterol*. 2005; 19:313–21. [PubMed: 15925838]
72. Dewar DH, Ciclitira PJ. Clinical features and diagnosis of celiac disease. *Gastroenterology*. 2005; 128:S19–24. [PubMed: 15825122]
73. Fasano A, Catassi C. Coeliac disease in children. *Best Pract Res Clin Gastroenterol*. 2005; 19:467–78. [PubMed: 15925850]
74. Nachman F, Maurino E, Vazquez H, et al. Quality of life in celiac disease patients: prospective analysis on the importance of clinical severity at diagnosis and the impact of treatment. *Dig Liver Dis*. 2009; 41:15–25. [PubMed: 18602354]
75. Ascher H, Holm K, Kristiansson B, et al. Different features of coeliac disease in two neighbouring countries. *Arch Dis Child*. 1993; 69:375–80. [PubMed: 8215549]
76. Bardella MT, Fredella C, Saladino V, et al. Gluten intolerance: gender- and age-related differences in symptoms. *Scand J Gastroenterol*. 2005; 40:15–9. [PubMed: 15841709]
77. McGowan KE, Castiglione DA, Butzner JD. The changing face of childhood celiac disease in north america: impact of serological testing. *Pediatrics*. 2009; 124:1572–8. [PubMed: 19948628]
78. Visakorpi JK, Maki M. Changing clinical features of coeliac disease. *Acta Paediatr Suppl*. 1994; 83:10–3. [PubMed: 8025351]
79. Fasano A. Clinical presentation of celiac disease in the pediatric population. *Gastroenterology*. 2005; 128:S68–73. [PubMed: 15825129]
80. Meloni G, Dore A, Fanciulli G, et al. Subclinical coeliac disease in schoolchildren from northern Sardinia. *Lancet*. 1999; 353:37. [PubMed: 10023953]
81. Corazza GR, Frisoni M, Treggiari EA, et al. Subclinical celiac sprue. Increasing occurrence and clues to its diagnosis. *J Clin Gastroenterol*. 1993; 16:16–21. [PubMed: 8421137]
82. Bottaro G, Cataldo F, Rotolo N, et al. The clinical pattern of subclinical/silent celiac disease: an analysis on 1026 consecutive cases. *Am J Gastroenterol*. 1999; 94:691–6. [PubMed: 10086653]
83. Moreno ML, Vazquez H, Mazure R, et al. Stratification of bone fracture risk in patients with celiac disease. *Clin Gastroenterol Hepatol*. 2004; 2:127–34. [PubMed: 15017617]
84. Baccini F, Spiriti MA, Vannella L, et al. Unawareness of gastrointestinal symptomatology in adult coeliac patients with unexplained iron-deficiency anaemia presentation. *Aliment Pharmacol Ther*. 2006; 23:915–21. [PubMed: 16573794]
85. Koskinen O, Collin P, Korponay-Szabo I, et al. Gluten-dependent small bowel mucosal transglutaminase 2-specific IgA deposits in overt and mild enteropathy coeliac disease. *J Pediatr Gastroenterol Nutr*. 2008; 47:436–42. [PubMed: 18852635]
86. Tjon JM, van Bergen J, Koning F. Celiac disease: how complicated can it get? *Immunogenetics*. 2010; 62:641–51. [PubMed: 20661732]
87. Ciacci C, Maiuri L, Russo I, et al. Efficacy of budesonide therapy in the early phase of treatment of adult coeliac disease patients with malabsorption: an in vivo/in vitro pilot study. *Clin Exp Pharmacol Physiol*. 2009; 36:1170–6. [PubMed: 19473192]
88. West J, Logan RF, Hill PG, et al. The iceberg of celiac disease: what is below the waterline? *Clin Gastroenterol Hepatol*. 2007; 5:59–62. [PubMed: 17234556]



89. Schuppan D, Kelly CP, Krauss N. Monitoring non-responsive patients with celiac disease. *Gastrointest Endosc Clin N Am*. 2006; 16:593–603. [PubMed: 16876729]
90. Holtmeier W, Caspary WF. Celiac disease. *Orphanet J Rare Dis*. 2006; 1:3. [PubMed: 16722573]
91. Lahdeaho ML, Kaukinen K, Collin P, et al. Celiac disease: from inflammation to atrophy: a long-term follow-up study. *J Pediatr Gastroenterol Nutr*. 2005; 41:44–8. [PubMed: 15990629]
92. Karnam US, Felder LR, Raskin JB. Prevalence of occult celiac disease in patients with iron-deficiency anemia: a prospective study. *South Med J*. 2004; 97:30–4. [PubMed: 14746419]
93. Barera G, Bonfanti R, Viscardi M, et al. Occurrence of celiac disease after onset of type 1 diabetes: a 6-year prospective longitudinal study. *Pediatrics*. 2002; 109:833–8. [PubMed: 11986443]
94. Volta U, Bellentani S, Bianchi FB, et al. High prevalence of celiac disease in Italian general population. *Dig Dis Sci*. 2001; 46:1500–5. [PubMed: 11478502]
95. Ciacci C, Cirillo M, Giorgetti G, et al. Low plasma cholesterol: a correlate of nondiagnosed celiac disease in adults with hypochromic anemia. *Am J Gastroenterol*. 1999; 94:1888–91. [PubMed: 10406254]
96. Falth-Magnusson K, Franzen L, Jansson G, et al. Infant feeding history shows distinct differences between Swedish celiac and reference children. *Pediatr Allergy Immunol*. 1996; 7:1–5. [PubMed: 8792377]
97. Doherty M, Barry RE. Gluten-induced mucosal changes in subjects without overt small-bowel disease. *Lancet*. 1981; 1:517–20. [PubMed: 6111631]
98. Ciacci C, Cirillo M, Mellone M, et al. Hypocalciuria in overt and subclinical celiac disease. *Am J Gastroenterol*. 1995; 90:1480–4. [PubMed: 7661174]
99. Polanco I, Mearin ML, Larrauri J, et al. Effect of gluten supplementation in healthy siblings of children with celiac disease. *Gastroenterology*. 1987; 92:678–81. [PubMed: 3817390]
100. Caputo M, Brizzolara R, Schiavo M, et al. Occurrence of overt celiac disease in the elderly following total thyroidectomy. *J Endocrinol Invest*. 2006; 29:831–3. [PubMed: 17114916]
101. Roshan B, Leffler DA, Jamma S, et al. The incidence and clinical spectrum of refractory celiac disease in a north american referral center. *Am J Gastroenterol*. 2011; 106:923–8. [PubMed: 21468013]
102. van de Water JM, Cillessen SA, Visser OJ, et al. Enteropathy associated T-cell lymphoma and its precursor lesions. *Best Pract Res Clin Gastroenterol*. 2010; 24:43–56. [PubMed: 20206108]
103. Walker MM, Murray JA. An update in the diagnosis of coeliac disease. *Histopathology*. 2010
104. Rubio-Tapia A, Murray JA. Classification and management of refractory coeliac disease. *Gut*. 2010; 59:547–57. [PubMed: 20332526]
105. Ho-Yen C, Chang F, van der Walt J, et al. Recent advances in refractory coeliac disease: a review. *Histopathology*. 2009; 54:783–95. [PubMed: 18700844]
106. Rubio-Tapia A, Kelly DG, Lahr BD, et al. Clinical staging and survival in refractory celiac disease: a single center experience. *Gastroenterology*. 2009; 136:99–107. quiz 352-3. [PubMed: 18996383]
107. Malamut G, Afchain P, Verkarre V, et al. Presentation and long-term follow-up of refractory celiac disease: comparison of type I with type II. *Gastroenterology*. 2009; 136:81–90. [PubMed: 19014942]
108. Verbeek WH, Goerres MS, von Blomberg BM, et al. Flow cytometric determination of aberrant intra-epithelial lymphocytes predicts T-cell lymphoma development more accurately than T-cell clonality analysis in Refractory Celiac Disease. *Clin Immunol*. 2008; 126:48–56. [PubMed: 18024205]
109. Al-Toma A, Verbeek WH, Mulder CJ. Update on the management of refractory coeliac disease. *J Gastrointest Liver Dis*. 2007; 16:57–63. [PubMed: 17410290]
110. Maurino E, Niveloni S, Chernavsky AC, et al. Clinical characteristics and long-term outcome of patients with refractory sprue diagnosed at a single institution. *Acta Gastroenterol Latinoam*. 2006; 36:10–22. [PubMed: 16706073]
111. Daum S, Cellier C, Mulder CJ. Refractory coeliac disease. *Best Pract Res Clin Gastroenterol*. 2005; 19:413–24. [PubMed: 15925846]

112. Biagi F, Corazza GR. Defining gluten refractory enteropathy. *Eur J Gastroenterol Hepatol.* 2001; 13:561–5. [PubMed: 11396537]
113. Daum S, Weiss D, Hummel M, et al. Frequency of clonal intraepithelial T lymphocyte proliferations in enteropathy-type intestinal T cell lymphoma, coeliac disease, and refractory sprue. *Gut.* 2001; 49:804–12. [PubMed: 11709515]
114. When is a coeliac a coeliac? Report of a working group of the United European Gastroenterology Week in Amsterdam, 2001. *Eur J Gastroenterol Hepatol.* 2001; 13:1123–8. [PubMed: 11564968]
115. Cellier C, Delabesse E, Helmer C, et al. Refractory sprue, coeliac disease, and enteropathy-associated T-cell lymphoma. French Coeliac Disease Study Group. *Lancet.* 2000; 356:203–8. [PubMed: 10963198]
116. Patey-Mariaud De Serre N, Cellier C, Jabri B, et al. Distinction between coeliac disease and refractory sprue: a simple immunohistochemical method. *Histopathology.* 2000; 37:70–7. [PubMed: 10931221]
117. Bagdi E, Diss TC, Munson P, et al. Mucosal intra-epithelial lymphocytes in enteropathy-associated T-cell lymphoma, ulcerative jejunitis, and refractory celiac disease constitute a neoplastic population. *Blood.* 1999; 94:260–4. [PubMed: 10381521]
118. Cellier C, Patey N, Mauvieux L, et al. Abnormal intestinal intraepithelial lymphocytes in refractory sprue. *Gastroenterology.* 1998; 114:471–81. [PubMed: 9496937]
119. Fine KD, Meyer RL, Lee EL. The prevalence and causes of chronic diarrhea in patients with celiac sprue treated with a gluten-free diet. *Gastroenterology.* 1997; 112:1830–8. [PubMed: 9178673]
120. Vahedi K, Mascart F, Mary JY, et al. Reliability of antitransglutaminase antibodies as predictors of gluten-free diet compliance in adult celiac disease. *Am J Gastroenterol.* 2003; 98:1079–87. [PubMed: 12809831]
121. Leffler DA, Dennis M, Hyett B, et al. Etiologies and predictors of diagnosis in nonresponsive celiac disease. *Clin Gastroenterol Hepatol.* 2007; 5:445–50. [PubMed: 17382600]
122. Fan X, Sellin JH. Review article: Small intestinal bacterial overgrowth, bile acid malabsorption and gluten intolerance as possible causes of chronic watery diarrhoea. *Aliment Pharmacol Ther.* 2009; 29:1069–77. [PubMed: 19222407]
123. Abdulkarim AS, Burgart LJ, See J, et al. Etiology of nonresponsive celiac disease: results of a systematic approach. *Am J Gastroenterol.* 2002; 97:2016–21. [PubMed: 12190170]
124. Johnston SD, Watson RG, Middleton D, et al. Genetic, morphometric and immunohistochemical markers of latent coeliac disease. *Eur J Gastroenterol Hepatol.* 1999; 11:1283–8. [PubMed: 10563541]
125. Meloni GF, Dessole S, Vargiu N, et al. The prevalence of coeliac disease in infertility. *Hum Reprod.* 1999; 14:2759–61. [PubMed: 10548618]
126. National Institutes of Health Consensus Development Conference Statement on Celiac Disease, June 28–30, 2004. *Gastroenterology.* 2005; 128:S1–9. [PubMed: 15825115]
127. Ludvigsson JF, Brandt L, Montgomery SM. Symptoms and signs in individuals with serology positive for celiac disease but normal mucosa. *BMC Gastroenterol.* 2009; 9:57. [PubMed: 19624815]
128. Ludvigsson JF, Montgomery SM, Ekbom A, et al. Small-intestinal histopathology and mortality risk in celiac disease. *JAMA.* 2009; 302:1171–8. [PubMed: 19755695]
129. Basso D, Guariso G, Fogar P, et al. Antibodies against synthetic deamidated gliadin peptides for celiac disease diagnosis and follow-up in children. *Clin Chem.* 2009; 55:150–7. [PubMed: 18988751]
130. Corazza GR, Andreani ML, Biagi F, et al. Clinical, pathological, and antibody pattern of latent celiac disease: report of three adult cases. *Am J Gastroenterol.* 1996; 91:2203–7. [PubMed: 8855749]
131. Ferguson A, Blackwell JN, Barnetson RS. Effects of additional dietary gluten on the small-intestinal mucosa of volunteers and of patients with dermatitis herpetiformis. *Scand J Gastroenterol.* 1987; 22:543–9. [PubMed: 3629179]

132. Murray IA, Smith JA, Coupland K, et al. Intestinal disaccharidase deficiency without villous atrophy may represent early celiac disease. *Scand J Gastroenterol.* 2001; 36:163–8. [PubMed: 11252408]
133. Kurppa K, Ashorn M, Iltanen S, et al. Celiac disease without villous atrophy in children: a prospective study. *J Pediatr.* 2010; 157:373–80. 80, e1. [PubMed: 20400102]
134. Kurppa K, Collin P, Viljamaa M, et al. Diagnosing mild enteropathy celiac disease: a randomized, controlled clinical study. *Gastroenterology.* 2009; 136:816–23. [PubMed: 19111551]
135. Freeman HJ, Chiu BK. Multifocal small bowel lymphoma and latent celiac sprue. *Gastroenterology.* 1986; 90:1992–7. [PubMed: 3699415]
136. Hovdenak N, Hovlid E, Aksnes L, et al. High prevalence of asymptomatic coeliac disease in Norway: a study of blood donors. *Eur J Gastroenterol Hepatol.* 1999; 11:185–7. [PubMed: 10102231]
137. Moayyedi P, O’Mahony S, Jackson P, et al. Small intestine in lymphocytic and collagenous colitis: mucosal morphology, permeability, and secretory immunity to gliadin. *J Clin Pathol.* 1997; 50:527–9. [PubMed: 9378824]
138. Biagi F, Luinetti O, Campanella J, et al. Intraepithelial lymphocytes in the villous tip: do they indicate potential coeliac disease? *J Clin Pathol.* 2004; 57:835–9. [PubMed: 15280404]
139. Arranz E, Bode J, Kingstone K, et al. Intestinal antibody pattern of coeliac disease: association with gamma/delta T cell receptor expression by intraepithelial lymphocytes, and other indices of potential coeliac disease. *Gut.* 1994; 35:476–82. [PubMed: 8174984]
140. Maki M, Holm K, Collin P, et al. Increase in gamma/delta T cell receptor bearing lymphocytes in normal small bowel mucosa in latent coeliac disease. *Gut.* 1991; 32:1412–4. [PubMed: 1836446]
141. Maki M, Huupponen T, Holm K, et al. Seroconversion of reticulins autoantibodies predicts coeliac disease in insulin dependent diabetes mellitus. *Gut.* 1995; 36:239–42. [PubMed: 7883223]
142. Ferguson A, Arranz E, O’Mahony S. Clinical and pathological spectrum of coeliac disease--active, silent, latent, potential. *Gut.* 1993; 34:150–1. [PubMed: 8432463]
143. Lebwahl B, Kapel RC, Neugut AI, et al. Adherence to biopsy guidelines increases celiac disease diagnosis. *Gastrointest Endosc.* 2011; 74:103–9. [PubMed: 21601201]
144. Hummel S, Hummel M, Banholzer J, et al. Development of autoimmunity to transglutaminase C in children of patients with type 1 diabetes: relationship to islet autoantibodies and infant feeding. *Diabetologia.* 2007; 50:390–4. [PubMed: 17171363]
145. Liu E, Li M, Emery L, et al. Natural history of antibodies to deamidated gliadin peptides and transglutaminase in early childhood celiac disease. *J Pediatr Gastroenterol Nutr.* 2007; 45:293–300. [PubMed: 17873740]
146. Simmons JH, Klingensmith GJ, McFann K, et al. Impact of celiac autoimmunity on children with type 1 diabetes. *J Pediatr.* 2007; 150:461–6. [PubMed: 17452216]
147. Diniz-Santos DR, Brandao F, Adan L, et al. Bone mineralization in young patients with type 1 diabetes mellitus and screening-identified evidence of celiac disease. *Dig Dis Sci.* 2008; 53:1240–5. [PubMed: 17939041]
148. De Block CE, De Leeuw IH, Vertommen JJ, et al. Beta-cell, thyroid, gastric, adrenal and coeliac autoimmunity and HLA-DQ types in type 1 diabetes. *Clin Exp Immunol.* 2001; 126:236–41. [PubMed: 11703366]
149. Catassi C, Kryszak D, Bhatti B, et al. Natural history of celiac disease autoimmunity in a USA cohort followed since 1974. *Ann Med.* 2010; 42:530–8. [PubMed: 20868314]
150. Stene LC, Honeyman MC, Hoffenberg EJ, et al. Rotavirus infection frequency and risk of celiac disease autoimmunity in early childhood: a longitudinal study. *Am J Gastroenterol.* 2006; 101:2333–40. [PubMed: 17032199]
151. Norris JM, Barriga K, Hoffenberg EJ, et al. Risk of celiac disease autoimmunity and timing of gluten introduction in the diet of infants at increased risk of disease. *Jama.* 2005; 293:2343–51. [PubMed: 15900004]
152. Dezsofi A, Szebeni B, Hermann CS, et al. Frequencies of genetic polymorphisms of TLR4 and CD14 and of HLA-DQ genotypes in children with celiac disease, type 1 diabetes mellitus, or both. *J Pediatr Gastroenterol Nutr.* 2008; 47:283–7. [PubMed: 18728522]

153. Fasano A. Celiac disease--how to handle a clinical chameleon. *N Engl J Med.* 2003; 348:2568–70. [PubMed: 12815143]
154. van Heel DA, Franke L, Hunt KA, et al. A genome-wide association study for celiac disease identifies risk variants in the region harboring IL2 and IL21. *Nat Genet.* 2007; 39:827–9. [PubMed: 17558408]
155. Newnham ED. Does gluten cause gastrointestinal symptoms in subjects without coeliac disease? *J Gastroenterol Hepatol.* 2011; 26 (Suppl 3):132–4. [PubMed: 21443726]
156. Biesiekierski JR, Newnham ED, Irving PM, et al. Gluten causes gastrointestinal symptoms in subjects without celiac disease: a double-blind randomized placebo-controlled trial. *Am J Gastroenterol.* 2011; 106:508–14. quiz 15. [PubMed: 21224837]
157. Bizzaro N, Tozzoli R, Villalta D, et al. Cutting-Edge Issues in Celiac Disease and in Gluten Intolerance. *Clin Rev Allergy Immunol.* 2010
158. Poloni N, Vender S, Bolla E, et al. Gluten encephalopathy with psychiatric onset: case report. *Clin Pract Epidemiol Ment Health.* 2009; 5:16. [PubMed: 19558661]
159. Cascella NG, Kryszak D, Bhatti B, et al. Prevalence of celiac disease and gluten sensitivity in the United States clinical antipsychotic trials of intervention effectiveness study population. *Schizophr Bull.* 2011; 37:94–100. [PubMed: 19494248]
160. Ozdemir O, Mete E, Catal F, et al. Food intolerances and eosinophilic esophagitis in childhood. *Dig Dis Sci.* 2009; 54:8–14. [PubMed: 18594978]
161. Llorente-Alonso MJ, Fernandez-Acenero MJ, Sebastian M. Gluten intolerance: sex and age-related features. *Can J Gastroenterol.* 2006; 20:719–22. [PubMed: 17111054]
162. Humbert P, Pelletier F, Dreno B, et al. Gluten intolerance and skin diseases. *Eur J Dermatol.* 2006; 16:4–11. [PubMed: 16436335]
163. Kalaydjian AE, Eaton W, Cascella N, et al. The gluten connection: the association between schizophrenia and celiac disease. *Acta Psychiatr Scand.* 2006; 113:82–90. [PubMed: 16423158]
164. Sblattero D, Ventura A, Tommasini A, et al. Cryptic gluten intolerance in type 1 diabetes: identifying suitable candidates for a gluten free diet. *Gut.* 2006; 55:133–4. [PubMed: 16344582]
165. Helms S. Celiac disease and gluten-associated diseases. *Altern Med Rev.* 2005; 10:172–92. [PubMed: 16164373]
166. Gobbi G. Coeliac disease, epilepsy and cerebral calcifications. *Brain Dev.* 2005; 27:189–200. [PubMed: 15737700]
167. Volta U, De Giorgio R, Petrolini N, et al. Clinical findings and anti-neuronal antibodies in coeliac disease with neurological disorders. *Scand J Gastroenterol.* 2002; 37:1276–81. [PubMed: 12465725]
168. Leggio L, Abenavoli L, D'Angelo C, et al. Gluten-related cerebral hypoperfusion and neurologic disorders in coeliac patients. *Aliment Pharmacol Ther.* 2004; 20:821–2. author reply 22. [PubMed: 15379843]
169. Sardy M, Karpati S, Merkl B, et al. Epidermal transglutaminase (TGase 3) is the autoantigen of dermatitis herpetiformis. *J Exp Med.* 2002; 195:747–57. [PubMed: 11901200]
170. Hadjivassiliou M, Grunewald RA, Chattopadhyay AK, et al. Clinical, radiological, neurophysiological, and neuropathological characteristics of gluten ataxia. *Lancet.* 1998; 352:1582–5. [PubMed: 9843103]
171. Troncone R, Jabri B. Coeliac disease and gluten sensitivity. *J Intern Med.* 2011; 269:582–90. [PubMed: 21481018]
172. Massari S, Liso M, De Santis L, et al. Occurrence of Nonceliac Gluten Sensitivity in Patients with Allergic Disease. *Int Arch Allergy Immunol.* 2011; 155:389–94. [PubMed: 21346369]
173. Sapone A, Lammers KM, Casolaro V, et al. Divergence of gut permeability and mucosal immune gene expression in two gluten-associated conditions: celiac disease and gluten sensitivity. *BMC Med.* 2011; 9:23. [PubMed: 21392369]
174. Sapone A, Lammers KM, Mazzarella G, et al. Differential mucosal IL-17 expression in two gliadin-induced disorders: gluten sensitivity and the autoimmune enteropathy celiac disease. *Int Arch Allergy Immunol.* 2010; 152:75–80. [PubMed: 19940509]

175. Verdu EF. Editorial: Can gluten contribute to irritable bowel syndrome? *Am J Gastroenterol*. 2011; 106:516–8. [PubMed: 21378766]
176. de Magistris L, Familiari V, Pascotto A, et al. Alterations of the intestinal barrier in patients with autism spectrum disorders and in their first-degree relatives. *J Pediatr Gastroenterol Nutr*. 2010; 51:418–24. [PubMed: 20683204]
177. Signer E, Burgin-Wolff A, Berger R, et al. Antibodies to gliadin as a screening test for coeliac disease. A prospective study. *Helv Paediatr Acta*. 1979; 34:41–52. [PubMed: 372144]
178. O'Farrelly C, Kelly J, Hekkens W, et al. Alpha gliadin antibody levels: a serological test for coeliac disease. *Br Med J (Clin Res Ed)*. 1983; 286:2007–10.
179. Leffler DA, Schuppan D. Update on serologic testing in celiac disease. *Am J Gastroenterol*. 2010; 105:2520–4. [PubMed: 21131921]
180. Lagerqvist C, Dahlbom I, Hansson T, et al. Antigliadin immunoglobulin A best in finding celiac disease in children younger than 18 months of age. *J Pediatr Gastroenterol Nutr*. 2008; 47:428–35. [PubMed: 18852634]
181. Schwertz E, Kahlenberg F, Sack U, et al. Serologic assay based on gliadin-related nonapeptides as a highly sensitive and specific diagnostic aid in celiac disease. *Clin Chem*. 2004; 50:2370–5. [PubMed: 15472035]
182. Osman AA, Uhlig HH, Valdes I, et al. A monoclonal antibody that recognizes a potential coeliac-toxic repetitive pentapeptide epitope in gliadins. *Eur J Gastroenterol Hepatol*. 2001; 13:1189–93. [PubMed: 11711775]
183. Mendez E, Vela C, Immer U, et al. Report of a collaborative trial to investigate the performance of the R5 enzyme linked immunoassay to determine gliadin in gluten-free food. *Eur J Gastroenterol Hepatol*. 2005; 17:1053–63. [PubMed: 16148550]
184. Burgin-Wolff A, Gaze H, Hadziselimovic F, et al. Antigliadin and antiendomysium antibody determination for coeliac disease [see comments]. *Arch Dis Child*. 1991; 66:941–7. [PubMed: 1819255]
185. Dieterich W, Ehnis T, Bauer M, et al. Identification of tissue transglutaminase as the autoantigen of celiac disease [see comments]. *Nat Med*. 1997; 3:797–801. [PubMed: 9212111]
186. Sulkanen S, Halttunen T, Laurila K, et al. Tissue transglutaminase autoantibody enzyme-linked immunosorbent assay in detecting celiac disease [see comments]. *Gastroenterology*. 1998; 115:1322–8. [PubMed: 9834257]
187. Dieterich W, Laag E, Schopper H, et al. Autoantibodies to tissue transglutaminase as predictors of celiac disease [see comments]. *Gastroenterology*. 1998; 115:1317–21. [PubMed: 9834256]
188. Hadithi M, von Blomberg BM, Crusius JB, et al. Accuracy of serologic tests and HLA-DQ typing for diagnosing celiac disease. *Ann Intern Med*. 2007; 147:294–302. [PubMed: 17785484]
189. Cooke WT, Smith WT. Neurological disorders associated with adult coeliac disease. *Brain*. 1966; 89:683–722. [PubMed: 4163580]
190. Hadjivassiliou M, Sanders DS, Grunewald RA, et al. Gluten sensitivity: from gut to brain. *Lancet Neurol*. 2010; 9:318–30. [PubMed: 20170845]
191. Burk K, Farecki ML, Lamprecht G, et al. Neurological symptoms in patients with biopsy proven celiac disease. *Mov Disord*. 2009; 24:2358–62. [PubMed: 19845007]
192. Hadjivassiliou M, Aeschlimann P, Strigun A, et al. Autoantibodies in gluten ataxia recognize a novel neuronal transglutaminase. *Ann Neurol*. 2008; 64:332–43. [PubMed: 18825674]
193. Boscolo S, Sarich A, Lorenzon A, et al. Gluten ataxia: passive transfer in a mouse model. *Ann N Y Acad Sci*. 2007; 1107:319–28. [PubMed: 17804560]
194. Ihara M, Makino F, Sawada H, et al. Gluten sensitivity in Japanese patients with adult-onset cerebellar ataxia. *Intern Med*. 2006; 45:135–40. [PubMed: 16508226]
195. Hadjivassiliou M, Maki M, Sanders DS, et al. Autoantibody targeting of brain and intestinal transglutaminase in gluten ataxia. *Neurology*. 2006; 66:373–7. [PubMed: 16476935]
196. Hadjivassiliou M, Davies-Jones GA, Sanders DS, et al. Dietary treatment of gluten ataxia. *J Neurol Neurosurg Psychiatry*. 2003; 74:1221–4. [PubMed: 12933922]
197. Abele M, Schols L, Schwartz S, et al. Prevalence of antigliadin antibodies in ataxia patients. *Neurology*. 2003; 60:1674–5. [PubMed: 12771263]

198. Hadjivassiliou M, Grunewald R, Sharrack B, et al. Gluten ataxia in perspective: epidemiology, genetic susceptibility and clinical characteristics. *Brain*. 2003; 126:685–91. [PubMed: 12566288]
199. Luostarinen LK, Collin PO, Peraaho MJ, et al. Coeliac disease in patients with cerebellar ataxia of unknown origin. *Ann Med*. 2001; 33:445–9. [PubMed: 11585106]
200. van der Meer JB. Granular deposits of immunoglobulins in the skin of patients with dermatitis herpetiformis. An immunofluorescent study. *Br J Dermatol*. 1969; 81:493–503. [PubMed: 4183364]
201. Meyer LJ, Carioto L, Zone JJ. Dermatitis herpetiformis: extraction of intact IgA from granular deposits in dermal papillae. *J Invest Dermatol*. 1987; 88:559–63. [PubMed: 3553340]
202. Zone JJ, Meyer LJ, Petersen MJ. Deposition of granular IgA relative to clinical lesions in dermatitis herpetiformis. *Arch Dermatol*. 1996; 132:912–8. [PubMed: 8712841]
203. Fry L, Keir P, McMinn RM, et al. Small-intestinal structure and function and haematological changes in dermatitis herpetiformis. *Lancet*. 1967; 2:729–33. [PubMed: 4167248]
204. Fry L, Seah PP, Harper PG, et al. The small intestine in dermatitis herpetiformis. *J Clin Pathol*. 1974; 27:817–24. [PubMed: 4426977]
205. Bolotin D, Petronic-Rosic V. Dermatitis herpetiformis. Part I. Epidemiology, pathogenesis, and clinical presentation. *J Am Acad Dermatol*. 2011; 64:1017–24. quiz 25-6. [PubMed: 21571167]
206. Fry L, Seah PP, Riches DJ, et al. Clearance of skin lesions in dermatitis herpetiformis after gluten withdrawal. *Lancet*. 1973; 1:288–91. [PubMed: 4119171]
207. Leonard J, Haffenden G, Tucker W, et al. Gluten challenge in dermatitis herpetiformis. *N Engl J Med*. 1983; 308:816–9. [PubMed: 6339917]
208. Reunala T, Blomqvist K, Tarpila S, et al. Gluten-free diet in dermatitis herpetiformis. I. Clinical response of skin lesions in 81 patients. *Br J Dermatol*. 1977; 97:473–80. [PubMed: 588461]
209. Garioch JJ, Lewis HM, Sargent SA, et al. 25 years' experience of a gluten-free diet in the treatment of dermatitis herpetiformis. *Br J Dermatol*. 1994; 131:541–5. [PubMed: 7947207]
210. Smith JB, Tulloch JE, Meyer LJ, et al. The incidence and prevalence of dermatitis herpetiformis in Utah. *Arch Dermatol*. 1992; 128:1608–10. [PubMed: 1456754]
211. Hardman CM, Garioch JJ, Leonard JN, et al. Absence of toxicity of oats in patients with dermatitis herpetiformis. *N Engl J Med*. 1997; 337:1884–7. [PubMed: 9407155]
212. Collin P, Reunala T. Recognition and management of the cutaneous manifestations of celiac disease: a guide for dermatologists. *Am J Clin Dermatol*. 2003; 4:13–20. [PubMed: 12477369]
213. Caproni M, Antiga E, Melani L, et al. Guidelines for the diagnosis and treatment of dermatitis herpetiformis. *J Eur Acad Dermatol Venereol*. 2009; 23:633–8. [PubMed: 19470076]
214. Collin P, Pukkala E, Reunala T. Malignancy and survival in dermatitis herpetiformis: a comparison with coeliac disease. *Gut*. 1996; 38:528–30. [PubMed: 8707082]
215. Rostami K, Kerckhaert J, Tiemessen R, et al. Sensitivity of antiendomysium and antigliadin antibodies in untreated celiac disease: disappointing in clinical practice [see comments]. *Am J Gastroenterol*. 1999; 94:888–94. [PubMed: 10201452]

## SUMMARY BOX

### What is already known about this subject

1. There is a lack of consensus on the use of terms related to coeliac disease and gluten.
2. Variability in the use of terminology has led to difficulty when comparing and evaluating clinical studies and research findings.

### What are the new findings

1. The panel reached agreement regarding the definition of terms related to coeliac disease and/or gluten currently in use in clinical practice and research.
2. Some terms in current use should be abandoned because they are outdated or misleading.

### How might it impact on clinical practice in the foreseeable future?

1. Uniform definitions for common terms relating to coeliac disease will improve communication between researchers, clinicians, and the general public, and will ensure that research is conducted and reported in a consistent manner.

Table 1

Terms evaluated for this review.

Term	PubMed hits until Jan 2011*
<b>Defined</b>	
Coeliac disease (CD) <sup>#</sup>	14,843
Asymptomatic CD	39
Classical CD	10
Paediatric classical CD <sup>#</sup>	-
Non-classical	3
Potential CD	33
Refractory CD	109
Subclinical CD	43
Symptomatic CD	26
CD autoimmunity <sup>§</sup>	16
Genetically at risk of CD <sup>#</sup>	-
Dermatitis Herpetiformis <sup>#</sup>	2759
Gluten <sup>#</sup>	8879
Gluten ataxia	28
Non-coeliac gluten sensitivity	85
Gliadin-specific antibodies <sup>‡</sup>	5
Overt CD	10
Gluten related disorders	12
<b>Discouraged</b>	
Atypical CD	13
Latent CD	78
Typical CD	11
Gluten intolerance	244
Gluten sensitivity	241
Silent CD	80
CD serology <sup>¶</sup>	15

\* We searched PubMed for the period Jan 1, 1900 to Jan 31, 2011. Individual co-authors then examined papers deemed most relevant. Where the phrase “coeliac disease” is part of the definition, we searched PubMed for the relevant term *and* coeliac disease (British and American spelling). For example, “*silent coeliac disease*”[All Fields] OR “*silent coeliac disease*”[All Fields] AND (“1900/01/01”[PDAT]: “2011/01/31”[PDAT])

<sup>#</sup> For these terms, our literature review was entirely based on expert consensus of the literature because it was beyond the scope of this paper to review all papers identified through PubMed (or as in the case of “paediatric classical CD” there were no hits).

<sup>§</sup> We searched both “Coeliac disease autoimmunity” and “coeliac autoimmunity” (both British and American spelling)

<sup>‡</sup> A search for “gluten and antibodies” yielded 2,529 hits.

<sup>¶</sup> Although we discourage the use of “CD serology”, we have defined this term in the paper.



**Table 2**

Comparison of histopathological classifications.

Morphology of duodenal mucosal biopsy	Classification		
	Marsh <sup>* 7</sup>	Marsh-Oberhuber <sup>16, 215</sup>	Corazza <sup>10</sup>
Normal	Type 0	Type 0	Normal
Normal architecture and increased intraepithelial lymphocytes 25/100 enterocytes	Type 0	Type 0	Grade A
Normal architecture and increased intraepithelial lymphocytes 40/100 enterocytes	Type 1	Type 1	Grade A
Normal architecture and increased intraepithelial lymphocytes 40/100 enterocytes with crypt hyperplasia	Type 2	Type 2	Grade A
Partial villous atrophy and increased intraepithelial lymphocytes 40/25/100 enterocytes	Type 2 Hyperplastic lesion Crypt hyperplasia, increased crypt height and influx of inflammatory cells	Type 3 Destructive	Grade B1 Atrophic, villous to crypt ratio is less than 3:1
		Type 3a Partial villous atrophy; villi blunt and shortened with a villous: crypt ratio, 1:1	
		Type 3b Subtotal villous atrophy; villi atrophic but still separate and recognisable	
Total villous atrophy intraepithelial lymphocytes 40/25/100 enterocytes	Type 3 Destructive Severe inflammation, flat villi; hyperplastic crypts	Type 3c Total villous atrophy; villi rudimentary or absent; mucosa resembles colonic mucosa	Grade B2 Atrophic, villi are no longer detectable
Atrophic hypoplastic lesion: flat mucosa, normal crypt height, no inflammation with normal intraepithelial lymphocyte counts	No equivalent	Type 4	No equivalent

\* Marsh initially explored the association of mucosal damage with a progressively increased gluten intake in treated CD patients. This staging has since been used as a classification.