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Original article

Diet adherence and gluten exposure in coeliac disease and self-reported non-coeliac gluten sensitivity

A. Løvik [a, 1], G. Skodje [a], J. Bratlie [b, c], M. Brottveit [d], K.E.A. Lundin [c, e, f, *]

[a] Department of Clinical Service, Division of Cancer Medicine, Surgery and Transplantation, Oslo University Hospital Rikshospitalet, Norway
[b] Research Institute of Internal Medicine, Oslo University Hospital Rikshospitalet, Norway
[c] Department of Gastroenterology, Oslo University Hospital Rikshospitalet, Norway
[d] Department of Gastroenterology, Oslo University Hospital Ullevål, Norway
[e] Centre for Immune Regulation, University of Oslo, Norway
[f] Faculty of Medicine, University of Oslo, Norway

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SUMMARY

Background/objectives: Adherence to gluten-free diet in self reported non-coeliac gluten sensitive subjects is scarcely researched. Objectives of the study were to compare dietary adherence in coeliac disease (CD) subjects and in non-coeliac gluten sensitive (NCGS) subjects, and to estimate gluten exposure based on weighed food records and analysis of gluten content in selected food items.

Subjects/methods: Twenty-three subjects with biopsy verified CD on a gluten-free diet and 34 HLA-DQ2^{+} NCGS subjects on a self-instituted gluten-free diet were enrolled. The latter group was under investigation of CD. Dietary adherence was assessed by frequency questionnaire and structured forms supplied by weighed food records. For the analyses of food samples, the sandwich R5-ELISA, Ridascreen® Gliadin competitive method was used.

Results: There was no difference in dietary adherence between CD and NCGS subjects (83% vs 68%, $p = 0.21$). NCGS subjects were mainly self-educated in gluten-free diet compared to CD subjects (91% and 39%, respectively, $p < 0.001$). In non-adherent subjects, there was no difference in gluten exposure between CD and NCGS (10 vs 138 mg/day, $p = 0.83$). There was no difference in BMR-factor between CD and NCGS subjects, or between adherent and non-adherent subjects.

Conclusions: Both CD and NCGS subjects were largely adherent, and adherence did not differ between the groups. Gluten exposure varied greatly, and some CD and NCGS subjects reached gluten intake above 500 mg/day, which might have considerable health effects on the individual, especially in case of coeliac disease.

1. Introduction

Coeliac disease (CD) is one of the most common inflammatory diseases of the small intestine. This chronic immune-mediated enteropathy occurs exclusively in genetically predisposed individuals after exposure to gluten. The only current treatment of CD is a strict, life-long gluten-free diet, which usually allows the affected mucosa to heal [1].

Gluten has also been associated with non-coeliac gluten sensitivity (NCGS), a syndrome reported to be slightly more prevalent than CD [2]. NCGS, non-coeliac wheat sensitivity (NCWS) [3] or persons who avoid wheat and/or gluten (PWAWG) [4] are conditions in which ingestion of gluten containing food leads to clinical signs compatible with CD, but without the typical histological and serological signs seen in CD. Increase of intraepithelial lymphocytes

Abbreviations: ATI, amylase-trypsin inhibitor; BMI, body mass index; BMR, basal metabolic rate; BMR-factor, energy intake and basal metabolic rate-ratio; CD, coeliac disease; EI, energy intake; ELISA, enzyme linked immunosorbent assay; FODMAP, fermentable oligo-di-monosaccharides and polyols; HLA, human leucocyte antigen; NCGS, non-coeliac gluten sensitivity; NCWS, non-coeliac wheat sensitivity; NIH, National Institutes of Health; NS, non statistical; PWAWG, persons who avoid wheat and/or gluten; SPSS, Statistical Package for the Social Sciences.

* Corresponding author. Department of Gastroenterology, Oslo University Hospital Rikshospitalet, Norway. Tel.: +47 23072400.
E-mail addresses: astridmargretel@gmail.com (A. Løvik), gry.skodje@ous-hf.no (G. Skodje), jbratlie@ous-hf.no (J. Bratlie), margit.brottveit@gmail.com (M. Brottveit), knut.lundin@medisin.uio.no (K.E.A. Lundin).
[1] Present address: Nordengvn 85 D, 0755 Oslo, Norway. Tel.: +47 99439941.

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and increased IgG to gluten is frequently seen but these tests are not diagnostic for the condition [5]. However, the underlying mechanisms are unknown, and the reports on effect of gluten withdrawal in subjects with self-reported NCGS are conflicting [6–8]. It has been suggested that the symptoms could be caused by intolerance to fermentable oligo-, di-, monosaccharides, and polyols (FODMAP) [7] or amylase-trypsin inhibitors (ATI) [9], which coexist with gluten in wheat.

Adherence to a gluten-free diet is of crucial importance for successful treatment of CD. Poor adherence could hamper sufficient restitution of the intestinal mucosa and reduce some protection against development of autoimmune co-morbidities, possibly resulting in an increased need for health care [10,11]. A systematic review indicates rates of strict dietary adherence in CD patients to be 44–90% [12]. Adherence in NCGS is largely unknown.

The primary objectives of this study were to assess diet adherence and gluten exposure in CD and NCGS subjects.

This study compares adherence in two groups depending on gluten-free diet. Estimation of gluten exposure is based on weighed food records and gluten analysis of food samples. This allows a precise quantification of gluten exposure.

2. Materials and methods

2.1. Subjects

We compared two groups of subjects. The HLA-DQ2$^+$ CD patients (one HLA-DQ8$^+$) diagnosed according to NIH 2004 criteria [13] were recruited from outpatient clinics at Oslo University Hospital (n = 11) and through Norwegian Coeliac Society by advertisements (n = 13). These patients (mean age 43, range 18–65 years) are referred to as CD subjects. Most of the perceived gluten sensitive HLA-DQ2$^+$ persons (n = 35) on a self-instituted gluten-free diet were recruited by advertisement in a daily newspaper and investigated as described elsewhere [14]. Previously the cohort (mean age 41, range 17–65 years) had not been properly investigated for CD. During work up three of the gluten sensitive persons were diagnosed as CD patients [14]. However, in this paper they are included in the NCGS cohort. Both groups were investigated by clinical and nutritional examination before inclusion. Specific diagnoses or diet avoidances are summarised in Table 1. Threshold values of specific IgE to wheat was found in one of 33 examined subjects as documented elsewhere [14]. We also know that 26% of the NCGS subjects in Brottveit et al., which is also part of this material, fulfilled the Rome II criteria retrospectively for IBS [15]. Their symptoms at inclusion were scored by GSRS-IBS and SHC formulas. All NCGS subjects reported symptom relief on gluten-free diet. Morphology, immune response and symptoms after gluten challenge in the cohort are published elsewhere [14–16].

One CD and one NCGS subjects were reluctant to be interviewed. Thus 23 CD subjects and 34 NCGS subjects were included in the study.

2.2. Dietary assessment

Subjects were interviewed about their meal situation, and their use of gluten-free and naturally gluten-free products, by means of a frequency questionnaire and standardised questions related to diet understanding and diet practice, i.e.: “Why did you start gluten-free diet?” and “Do you get symptoms when tasting gluten containing food?”

After thorough instruction, subjects recorded their food intake (weighed food records) for three consecutive days (one week-end-day, two working days). They were told to maintain their usual gluten-free diet and to record recipes and brand names of all products consumed.

Adherence to gluten-free diet was graded into four categories: good, fair, poor and non-adherent. Good adherence was based on intake of always known gluten-free food ingredients when eating at home and away from home, always checking of labels, and no voluntary transgression. Fair adherence included possible risks like less checking of ingredients, and no asking for ingredients in menus when eating out. Poor adherence included additional obvious risks like consuming food of unknown composition, tasting of gluten containing food or having regular beer weekly or more frequently. When eating regular meals in periods, the subjects were considered non-adherent. In the statistical analysis good and fair adherence were recoded into “adherent”, and poor and non-adherent were recoded into “non-adherent”. Reported intakes of regular food used less frequently than once a month, were not included in the calculations of gluten exposure. Energy intake was calculated by means of the Norwegian Food Composition Table (http://www.matvaretabellen.no/).

Underreporting of food intake was assessed by calculated energy intake (EI) and calculated basal metabolic rate (BMR). The cut-off point of BMR-factor (EI/BMR-ratio) for the relevant number of subjects and days of records was chosen [17]. A BMR-factor less than 1.47 was considered as underreported food intake.

2.3. Prolamin analyses and gluten calculations

Random sampling of grain, flours, seeds, bread mixes, products labelled gluten-free or naturally gluten-free products (n = 105),

Table 1
Characteristics by mean (SD) and median (Q_1, Q_3).

	CD (n = 23)	NCGS (n = 34)	p-Value	Male (n = 11)	Female (n = 46)	p-Value
Age (years)	43 (41)	41 (14)	0.50	38 (15)	43 (13)	0.28[a]
BMI (kg/m^2)	23 (3)	24 (4)	0.55	23 (3)	24 (4)	0.87[a]
Months on gluten-free diet	19 (12, 48)	15 (7, 28)	0.21	15 (8, 33)	16 (9, 75)	0.62[a]
Subjects sharing meals n (%)	18 (78)	21 (62)	0.27	7 (64)	33 (72)	0.59[b]
Avoiding milk n (%)	6 (26)	13 (38)	0.55	2 (18)	17 (37)	0.19[b]
Avoiding other foods n (%)[e]	5 (22)	11 (32)	0.38	4 (36)	12 (26)	0.49[b]
Total meals per day	5.2 (0.9)	4.9 (1.0)	0.25	4.8 (0.6)	5.1 (1.0)	0.49[a]
Bread meals per day	2.2 (0.8)[c]	1.8 (1.0)[d]	0.13	2.0 (0.6)	1.9 (1.0)	0.72[a]
Diabetes mellitus n (%)	2 (9)	0	0.16	1 (9)	1 (2)	0.35[b]
Thyroid disease n (%)	2 (9)	2 (6)	1.00	0	4 (9)	0.58[b]

Abbreviations: SD, standard deviation; CD, coeliac disease; NCGS, non-coeliac gluten sensitivity; BMI, body mass index; GF, gluten-free.
[a] T-test for equality of means.
[b] Chi square or Fisher exact test.
[c] n = 21.
[d] n = 32.
[e] Nut, shellfish, apple, egg.

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