

ORIGINAL ARTICLE

Perceived food intolerance in subjects with irritable bowel syndrome – etiology, prevalence and consequences

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Objectives: This study estimates the prevalence of perceived food intolerance and its consequences in subjects with irritable bowel syndrome (IBS), evaluates the utility of common tests for food intolerance, studies the relation between perceived food intolerance and other disorders, and discusses the etiology.

Design: Cross-sectional study.

Setting: National health survey.

Subjects: A selection of the population ($n = 11078$) in Oppland county, Norway, was invited to a health screening, and a sample of subjects with IBS were included in the study.

Interventions: A medical history of food intolerance, musculoskeletal pain, mood disorders and abdominal complaints was taken, and tests were performed for food allergy and malabsorption. A dietician evaluated the dietary habits of the subjects.

Results: Out of 4622 subjects with adequately filled-in questionnaires, 84 were included in the study, 59 (70%) had symptoms related to intake of food, 62% limited or excluded food items from the diet and 12% had an inadequate diet. The mean numbers of food items related to symptoms and the number of foods limited or excluded from the diet were 4.8 and 2.5, respectively. There were no associations between the tests for food allergy and malabsorption and perceived food intolerance. Perceived food intolerance was unrelated to musculoskeletal pain and mood disorders.

Conclusions: Perceived food intolerance is a common problem with significant nutritional consequences in a population with IBS. The uselessness of current antibody tests and tests for malabsorption and the lack of correlation to psychiatric co-morbidity make the etiology obscure.

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Introduction

Perceived food intolerance, defined as symptoms related to intake of food with or without objective findings, is reported by 25–65% of patients with irritable bowel syndrome (IBS) (Locke *et al.*, 2000; Simren *et al.*, 2001b; Zar *et al.*, 2001). It has been linked up with immunological, allergic, toxic and psychiatric mechanisms, but the etiology is poorly understood (Rix *et al.*, 1984; Nanda *et al.*, 1989; Zar *et al.*, 2001; Barbara *et al.*, 2002; Isolauri *et al.*, 2004). Musculoskeletal pain and psychiatric disorders are also common in these subjects (Vandvik and Farup, 2004; Vandvik *et al.*, 2004). Nearly all available information is based on studies in primary and secondary care, but, far from all subjects with

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Contributors: KWM wrote the protocol that was designed in collaboration by all the authors. KWM was the dietician responsible for the patients and collected all the information about dietary habits; POV was the physician responsible for the patients and collected the medical information. KWM and POV were responsible for the clean data file. PGF performed the statistical analyses and wrote the paper, which was critically revised and approved by all the authors.

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IBS, is seen by the health-care system. The prevalence and consequences of perceived food intolerance, and the relation to other disorders in subjects with IBS in the population, is less studied (Locke *et al.*, 2000). The high prevalence of IBS in the population (8–14%) makes this knowledge even more important (Thompson *et al.*, 2002; Vandvik and Farup, 2004).

This population-based cross-sectional study estimates the prevalence of perceived food intolerance and its consequences for dietary habits and nutrition in subjects with IBS, evaluates the utility of common diagnostic tests for food intolerance, studies the relation between perceived food intolerance and musculoskeletal pain and psychiatric disorders, and discusses the etiology of perceived food intolerance in the light of the findings.

Materials and methods

Subjects

All persons in Oppland County, Norway, born in 1970, 1960, 1955, 1940 and 1925, were invited to participate in a population-based health study (the OPPHED Study 2000–2001) conducted by the National Health Screening Service of Norway who also collected the data in 2001. All persons with IBS (according to the Rome II criteria) and ‘alarm symptoms’ were invited to the local hospital for further investigations, and those without organic disease were eligible for this study.

Study design

The study has a cross-sectional design. The participants had a consultation with a doctor interested in the management of patients with IBS and a dedicated dietician.

Methods

Health study. The participants in the OPPHED study filled in detailed questionnaires with information about age, sex, smoking habits, overall state of health, presence of fibromyalgia/chronic musculoskeletal pain syndrome (rated: yes, no) and previous or actual psychiatric disorder, for which they had applied for help (rated: yes, no). Musculoskeletal pain/stiffness in the neck/shoulders, arms/hands, upper back, lower back, hips/legs/feet and “other” during the last 4 weeks were registered, the duration of each symptom was noted as more or less than 2 weeks, and a musculoskeletal symptom score was calculated, with range 0–24. Hopkin Symptom Check List 10 (HSCL-10) with a cutoff value of 1.85 as the upper normal limit was used for the assessment of mood disorders (mainly anxiety and depression) (Strand *et al.*, 2003). The musculoskeletal questionnaire and HSCL-10 have been translated into Norwegian, validated and extensively used in the national surveys of the Norwegian Institute of Public Health. Abdominal complaints were

assessed with a questionnaire based on the Rome II criteria for functional bowel disorders, and the presence of ‘alarm symptoms’ (weight loss last year, blood in the stools and colorectal cancer in first-degree relatives) was noted.

Consultation at the local hospital. The participants filled in a questionnaire prior to any investigation. The frequency (≤ 1 day/week, 2–3 days/week, 4–5 days/week and > 5 days/week) and severity (none, mild, moderate, severe) of the abdominal symptoms were assessed, and a symptom score was calculated for each subject as the product of frequency and severity (range 0–12). They noted in detail their dietary habits and perceived food intolerance and specified the relation between abdominal symptoms and 31 food items.

All participants had a medical history of past and current disorders taken, including recent and concurrent medication, and a physical examination performed. Blood was collected for hematology and biochemistry, including food antibodies (total IgA, IgA and IgG against gliadin and gluten, IgA antibodies against lactalbumin, lactoglobulin, casein and ovalbumin), tests for celiac disease (serum endomysium or transglutaminase antibodies in subjects with elevated IgA or IgG against gliadin and gluten) and malabsorption. Tests were performed for lactose malabsorption (H_2 and CH_4 breath test) and *Helicobacter pylori* infection (ImmunoCard STAT HpSA, Orion Diagnostica). Subjects with recurrent, rapid onset of symptoms after intake of one or more specified food items were tested with total IgE and IgE antibodies against the specified food, and other tests like blood in the stools, upper g-i endoscopy with small bowel biopsies, colonoscopy, etc were performed when judged relevant. Subjects with an organic disease were excluded.

All participants had a consultation with a dedicated dietician and explained their opinion on the relation between symptoms and the diet. The dietician clarified their dietary habits and judged the nutrition with regard to health damage.

Statistics

The analyses were performed with *t*-test and Mann–Whitney *U*-test (for variables with and without normal distribution), χ^2 test (with linear-by-linear association when appropriate), κ -statistics and nonparametric correlation analyses (Spearman’s ρ) with the statistical packages SPSS[®] v.12 and StatXact[®] v.6. Two-tailed significance tests were used, *P*-values < 0.05 were regarded as statistically significant, 95% confidence intervals (CI) were calculated for the main variables, and exact tests were used when possible.

Ethics

The study was approved by the Regional Committee for Medical Research Ethics at the University of Oslo and The Data Inspectorate, Oslo, Norway, and performed according to the Declaration of Helsinki.

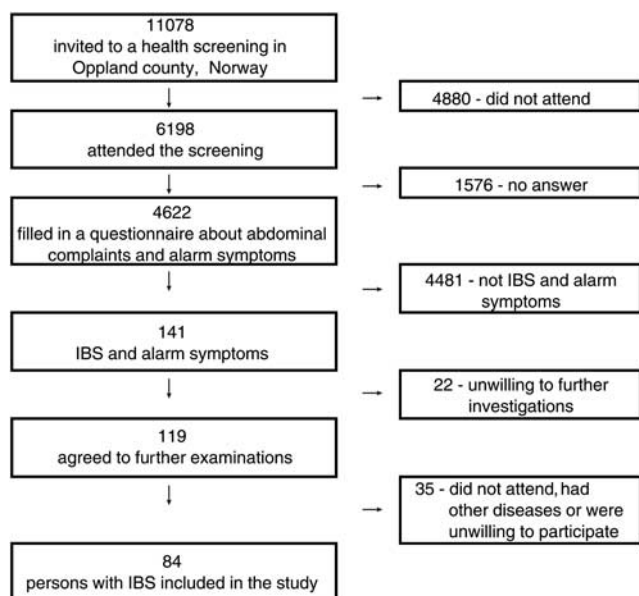


Figure 1 Number of subjects in the health-screening survey, and the selection of participants for the study.

Results

Out of 185 000 inhabitants in Oppland County, Norway, 11 078 were invited to participate in the health survey, 4622 filled in the questionnaire about abdominal symptoms and 388 had IBS. Figure 1 shows how 84 subjects with IBS and 'alarm symptoms' (26 men and 58 women) with mean age 48.5 years (s.d. 15.0) were selected from the health survey for participation in the study. In all, 59 subjects (70%) had symptoms of IBS related to intake of food, and the mean number of food items related to symptoms was 4.8 (range 0–19). Out of 82 subjects with completely filled-in questionnaires, 51 (62%) had limited or excluded food items from the diet, and the mean number of limited or excluded food items was 2.5 (range 0–14). Table 1 shows the relation between intolerance and avoidance against food and the individual food items. Altogether, 10 subjects (12%) were judged to have an inadequate diet, three of them had a low energy intake with under-nourishment and weight loss, two avoided fat to the extreme, two had an exceptionally unvaried diet and seven were at risk of vitamin and mineral deficiency (some subjects had more than one reason for an inadequate diet).

The agreement between intolerance to a food item and an abnormal test against the item was not statistically significant (Table 2). Tests for total serum-IgE and IgE antibodies against specific food were taken in 16 subjects, two had elevated total IgE and none had significantly elevated antibodies against specific food items.

Table 3 gives the characteristics of subjects with and without perceived food intolerance; there were no statisti-

Table 1 Number and proportion of subjects with abdominal symptoms related to intake of each food item, and the corresponding values for those who limit or exclude the food items from the diet

Food items (number of responses in brackets)	Perceived food intolerance (no. and proportion)	Limit or avoid the food (no. and proportion)
<i>Diary products and egg (84)</i>		
Milk	35 (41.7%)	29 (34.5%)
Cheese	12 (14.3%)	12 (14.3%)
Egg	10 (11.9%)	5 (6.0%)
<i>Vegetables (84)</i>		
Corn	8 (9.5%)	5 (6.0%)
Peas	18 (21.4%)	14 (16.7%)
Tomato	8 (9.5%)	3 (3.6%)
Green and red pepper	15 (17.9%)	11 (13.1%)
Celery	9 (10.7%)	4 (4.8%)
Onion	30 (35.7%)	20 (23.8%)
Cabbage	29 (34.5%)	24 (28.6%)
Potato	8 (9.5%)	0 (0.0%)
<i>Fruits and nuts (84)</i>		
Orange	11 (13.1%)	8 (9.5%)
Pear	9 (10.7%)	6 (7.1%)
Apple	12 (14.3%)	10 (11.9%)
Bananas	10 (11.9%)	7 (8.3%)
Nuts	15 (17.9%)	8 (9.5%)
<i>Cereals (84)</i>		
Flour from wheat	12 (14.3%)	9 (10.7%)
Pasta	7 (8.3%)	6 (7.1%)
White bread	11 (13.1%)	7 (8.3%)
Whole grain bread	4 (4.8%)	4 (4.8%)
Dark crisp bread	2 (2.4%)	1 (1.2%)
<i>Meat (84)</i>		
Dark meat	12 (14.3%)	12 (14.3%)
White meat	2 (2.4%)	2 (2.4%)
<i>Drinks and other (84)</i>		
Coffee	22 (26.2%)	22 (26.2%)
Tea	13 (15.5%)	8 (9.5%)
Chocolate	21 (25.0%)	9 (10.7%)
Sugarfree chewing – gum	5 (6.0%)	3 (3.6%)
<i>Alcohol (71)</i>		
Red wine	8 (11.3%)	4 (4.8%)
White wine	7 (9.9%)	1 (1.2%)
Beer	12 (16.9%)	10 (11.9%)
Brandy	10 (14.1%)	3 (3.6%)

cally significant differences between the groups. Figure 2 shows the correlations between perceived food intolerance (measured as the number of food items related to abdominal symptoms) and musculoskeletal pain score and mood disorders (HSCL-10); the correlations were not statistically significant. The correlation between musculoskeletal pain score and mood disorders (HSCL-10) was, on the other hand, highly statistically significant (Spearman's ρ 0.43, $P < 0.001$) (data not shown).

Table 2 Number and proportion of subjects with intolerance against some food items and the number and proportion with positive tests against the same foods, and the agreement between the perceived intolerance and tests for intolerance

Food item (no. of subjects)	Intolerance (no. and proportion)	Test	Positive test (no. and proportion)	Agreement	κ	95% CI	Significance
Milk and/or cheese (77)	35 (45%)	Lactose malabsorption	5 (6.5%)	58%	0.10	−0.03; 0.22	NS ($P = 0.25$)
Milk and/or cheese (79)	33 (42%)	Milk antibodies ^a	6 (7.6%)	61%	0.09	−0.05; 0.23	NS ($P = 0.39$)
Egg (79)	10 (13%)	Egg antibodies ^b	0 (0%)	87%	—	—	—
Food with gliadin/gluten (79)	18 (23%)	Gliadin/gluten antibodies ^c	15 (19%)	63%	−0.11	−0.30; 0.08	NS ($P = 0.50$)

NS = not significant.

^aIgA antibodies against lactalbumin, lactoglobulin or casein.^bIgA antibodies against ovalbumin.^cIgA or IgG antibodies against gliadin or gluten.**Table 3** Characteristics of subjects with and without perceived food intolerance

Characteristics	Food intolerance (no. 59)	No food intolerance (no. 25)	Statistics
Male/female (%)	27/32	40/60	NS ($P = 0.30$)
Age in years (mean, s.d.)	46.5 (14.2)	53.0 (16.0)	NS ($P = 0.07$)
BMI (mean, s.d.)	26.1 (4.0)	25.8 (5.8)	NS ($P = 0.84$)
Daily smokers (%)	23	36	NS ($P = 0.28$)
<i>Helicobacter pylori</i> positive (%)	18	27	NS ($P = 0.37$)
Abdominal symptom score (mean, s.d.)	3.1 (1.9)	3.2 (2.6)	NS ($P = 0.90$)
Diarrhoea predominant IBS (%)	48	29	NS ($P = 0.15$)
<i>State of health</i>			
Bad/not quite good/good/excellent (%)	4/33/51/12	0/63/29/8	NS ($P = 0.17$)
Fibromyalgia/chronic musculoskeletal pain syndrome (%)	20	24	NS ($P = 0.77$)
Musculoskeletal pain/stiffness score (mean, s.d.)	6.7 (5.0)	9.1 (7.2)	NS ($P = 0.13$)
Applied for help for psychiatric disorder (%)	32	32	NS ($P = 1.00$)
HSCL-10 score (mean, s.d.)	1.61 (0.55)	1.52 (0.30)	NS ($P = 0.35$)

The results are given as percentage or mean with s.d. BMI: Body mass index; NS = not significant. HSCL-10: Hopkin Symptom Check List 10.

Discussion

This population-based study shows that perceived food intolerance is highly prevalent (70%) and has considerable consequences in subjects with IBS. One other population-based study reports a prevalence rate of perceived food intolerance above 50% among subjects with IBS (Locke *et al.*, 2000). This is significantly higher than the prevalence reported in the general population, which is 20–25% (Young *et al.*, 1994; Locke *et al.*, 2000). The prevalence of perceived food intolerance in subjects with IBS in the population seems to be as high as the rates reported in studies in primary and secondary care, where 20–65% attribute their symptoms to adverse food reactions (Simren *et al.*, 2001b; Zar *et al.*, 2001). Milk seems to be the food item most frequently associated with the symptoms (Nanda *et al.*, 1989; Simren *et al.*, 2001b). Wheat and eggs are other products often associated with symptoms in other trials, whereas vegetables, coffee and chocolate were more frequently reported in this study.

The consequences of perceived food intolerance are less focused in literature than the intolerance *per se*. In all, 62%

of the population with IBS limited or excluded one or more food item from the diet (the mean number was 2.5) and 12% had made changes in their diet to such an extent that health damage was judged as possible in the long run. We are not aware of any population-based study of the consequences of perceived food intolerance. It is likely that the intolerance and dietary changes affect the quality of life, and have psychosocial and medical implications at least in those with extensive problems, but a detailed analysis of such consequences was not part of this study. The problem deserves attention since IBS is such a common disorder (Thompson *et al.*, 2002; Vandvik and Farup, 2004).

The etiology and pathogenesis of perceived food intolerance is poorly understood. Common tests for food antibodies and malabsorption are in most studies, like this one, to no avail (Dainese *et al.*, 1999; Farup *et al.*, 2004). The only exception might be screening for celiac disease, although no subjects with celiac disease were detected in this study (Sanders *et al.*, 2001). Perceived food intolerance is far more common in the population than demonstrable sensitization to food allergens, the prevalence rates are 20–25% and <6%,

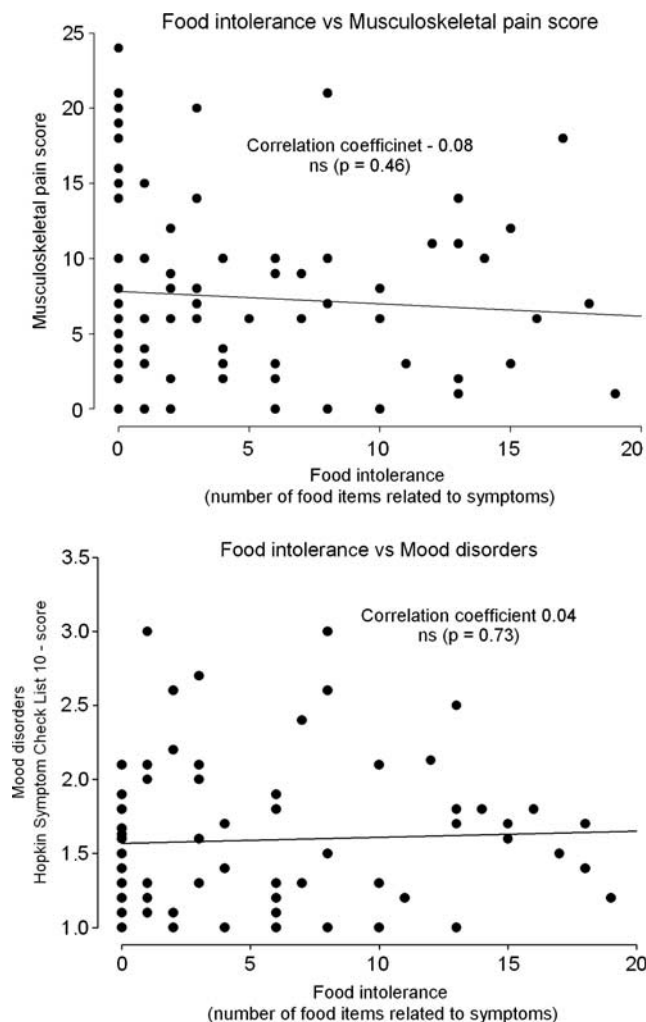


Figure 2 The correlation between food intolerance and musculoskeletal pain score (at the top) and mood disorders (at the bottom).

respectively, and symptoms seems to discriminate IBS from IgE-mediated food allergy (Young *et al.*, 1994; Gislason *et al.*, 1999; Locke *et al.*, 2000; Neri *et al.*, 2000). Lactose malabsorption is uncommon and unrelated to IBS in northern Europe where this study was carried out, but might be of importance elsewhere (Farup *et al.*, 2004). As the number of tests for food hypersensitivity/allergy was not exhaustive and food elimination-challenge tests were not performed, some cases with true nonallergic or allergic food intolerance might have been missed, such as delayed type food allergy. The significance of gliadin/gluten antibodies in subjects without celiac disease is unknown. But, in all, it is unlikely that known immunological or nonimmunological mechanisms can explain anything but a small proportion of perceived food intolerance in subjects with IBS.

Since organic mechanisms seldom explain perceived food intolerance and somatic unexplained comorbidity (like musculoskeletal pain) and psychiatric disorders are common in subjects with IBS (32% of the subjects in this study had applied for help for a psychiatric disorder compared to 14% of the population in Oppland), the symptoms could be attributed to psychiatric factors. This is supported by studies in specialized units. Patients presenting at an allergy clinic with supposed food allergy were almost identical, with new psychiatric out-patients referrals in terms of psychiatric symptomatology (Rix *et al.*, 1984). Since no such correlation is demonstrable in population-based studies like this one, the findings in specialized clinics are probably due to selection bias (Peveler *et al.*, 1996; Knibb *et al.*, 1999). The lack of correlation between perceived food intolerance and somatic unexplained comorbidity (like musculoskeletal pain) and psychiatric disorders in population-based studies make it unlikely that perceived food intolerance has a psychiatric etiology. Perceived food intolerance sets apart from fibromyalgia and musculoskeletal pain syndromes that are always, as in this study, correlated to psychiatric disorders (Vandvik and Farup, 2004; Vandvik *et al.*, 2004).

Since common tests for food intolerance and psychiatric disorders are unable to explain perceived food intolerance, other mechanisms should be evaluated. Psychological factors not measured in this study, such as attribution, might be involved in the pathogenesis. The established changes in visceral sensory, perceptual and neuroendocrine responses seen in these subjects has been related to low-grade mucosal inflammation, IgG antibodies and other aspects of food allergy, infections, changes in the microflora, etc (Simren *et al.*, 2001a; Barbara *et al.*, 2002; Isolauri *et al.*, 2004; Posserud *et al.*, 2004). All these aspects of perceived food intolerance deserve further investigations.

The study of subjects from a population-based national survey reduces the selection bias with regard to organic and psychiatric co-morbidity seen in studies from primary and secondary care, and is a major strength of this study. Although the attendance to the health survey was lower than desired, the impact of self-selection in a similar large population-based Norwegian survey was judged to have little impact on the results (Sogaard *et al.*, 2004). The inclusion of only those with IBS and 'alarm symptoms' was done for capacity reasons, and might have induced a bias. The subjects were included when thorough investigations had excluded organic disease, which assures that the diagnoses of IBS were correct. Moreover, after exclusion of subjects with organic disorders, the 'alarm symptoms' in the subjects taking part in the study were of minor or no importance and in part due to misunderstanding during the health screening. It is therefore unlikely that this has induced a selection bias.

IBS is a disorder presumed to be caused by adverse reactions to food; perceived food intolerance is common in these subjects, and dietary advice is part of the treatment recommendations (Ortolani *et al.*, 1999; Jones *et al.*, 2000).

Perceived food intolerance is, however, still in large an unexplained symptom. Common diagnostic tests are of little, if any, value, and psychiatric illness cannot explain the disorder, which has significant consequences for nutrition and state of health for a subset of the affected subjects.

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References

- Barbara G, De Giorgio R, Stanghellini V, Cremon C, Corinaldesi R (2002). A role for inflammation in irritable bowel syndrome? *Gut* **51** (Suppl 1), i41–i44.
- Dainese R, Galliani EA, De Lazzari FD, Leo VD, Naccarato R (1999). Discrepancies between reported food intolerance and sensitization test findings in irritable bowel syndrome patients. *Am J Gastroenterol* **94**, 1892–1897.
- Farup PG, Monsbakken KW, Vandvik PO (2004). Lactose malabsorption in a population with irritable bowel syndrome: prevalence and symptoms. A case-control study. *Scand J Gastroenterol* **39**, 645–649.
- Gislason D, Bjornsson E, Gislason T, Janson C, Sjöberg O, Elfman L *et al.* (1999). Sensitization to airborne and food allergens in Reykjavik (Iceland) and Uppsala (Sweden) – a comparative study. *Allergy* **54**, 1160–1167.
- Isolauri E, Rautava S, Kalliomaki M (2004). Food allergy in irritable bowel syndrome: new facts and old fallacies. *Gut* **53**, 1391–1393.
- Jones J, Boorman J, Cann P, Forbes A, Gomborone J, Heaton K *et al.* (2000). British Society of Gastroenterology guidelines for the management of the irritable bowel syndrome. *Gut* **47** (Suppl 2), ii1–ii19.
- Knibb RC, Armstrong A, Booth DA, Platts RG, Booth IW, MacDonald A (1999). Psychological characteristics of people with perceived food intolerance in a community sample. *J Psychosom Res* **47**, 545–554.
- Locke GR, Zinsmeister AR, Talley NJ, Fett SL, Melton LJ (2000). Risk factors for irritable bowel syndrome: role of analgesics and food sensitivities. *Am J Gastroenterol* **95**, 157–165.
- Nanda R, James R, Smith H, Dudley CR, Jewell DP (1989). Food intolerance and the irritable bowel syndrome. *Gut* **30**, 1099–1104.
- Neri M, Laterza F, Howell S, Di Gioacchino M, Festi D, Ballone E *et al.* (2000). Symptoms discriminate irritable bowel syndrome from organic gastrointestinal diseases and food allergy. *Eur J Gastroenterol Hepatol* **12**, 981–988.
- Ortolani C, Bruijnzeel-Koomen C, Bengtsson U, Bindslev-Jensen C, Bjorksten B, Host A *et al.* (1999). Controversial aspects of adverse reactions to food. European Academy of Allergy and Clinical Immunology (EAACI) Reactions to Food Subcommittee. *Allergy* **54**, 27–45.
- Peveler R, Mayou R, Young E, Stoneham M (1996). Psychiatric aspects of food-related physical symptoms: a community study. *J Psychosom Res* **41**, 149–159.
- Posserud I, Agerforz P, Ekman R, Bjornsson ES, Abrahamsson H, Simren M (2004). Altered visceral perceptual and neuroendocrine response in patients with irritable bowel syndrome during mental stress. *Gut* **53**, 1102–1108.
- Rix KJ, Pearson DJ, Bentley SJ (1984). A psychiatric study of patients with supposed food allergy. *Br J Psychiatry* **145**, 121–126.
- Sanders DS, Carter MJ, Hurlstone DP, Pearce A, Ward AM, McAlindon ME *et al.* (2001). Association of adult coeliac disease with irritable bowel syndrome: a case-control study in patients fulfilling ROME II criteria referred to secondary care. *Lancet* **358**, 1504–1508.
- Simren M, Abrahamsson H, Bjornsson ES (2001a). An exaggerated sensory component of the gastrocolonic response in patients with irritable bowel syndrome. *Gut* **48**, 20–27.
- Simren M, Mansson A, Langkilde AM, Svedlund J, Abrahamsson H, Bengtsson U *et al.* (2001b). Food-related gastrointestinal symptoms in the irritable bowel syndrome. *Digestion* **63**, 108–115.
- Sogaard AJ, Selmer R, Bjertness E, Thelle D (2004). The Oslo Health Study: the impact of self-selection in a large, population-based survey. *Int J Equity Health* **3**, 3.
- Strand BH, Dalgard OS, Tambs K, Rognerud M (2003). Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nord J Psychiatry* **57**, 113–118.
- Thompson WG, Irvine EJ, Pare P, Ferrazzi S, Rance L (2002). Functional gastrointestinal disorders in Canada: first population-based survey using Rome II criteria with suggestions for improving the questionnaire. *Digest Dis Sci* **47**, 225–235.
- Vandvik PO, Farup PG (2004). Irritable bowel syndrome in a Norwegian population: prevalence and association with mood disorders and musculoskeletal complaints. *Gastroenterology* **126** (Suppl 2), A-478.
- Vandvik PO, Wilhelmsen I, Ihlebaek C, Farup PG (2004). Comorbidity of irritable bowel syndrome in general practice: a striking feature with clinical implications. *Aliment Pharmacol Ther* **20**, 1195–1203.
- Young E, Stoneham MD, Petrukevitch A, Barton J, Rona R (1994). A population study of food intolerance. *Lancet* **343**, 1127–1130.
- Zar S, Kumar D, Benson MJ (2001). Food hypersensitivity and irritable bowel syndrome. *Aliment Pharmacol Ther* **15**, 439–449.