Dietary and FODMAP intake in newly diagnosed inflammatory bowel disease patients and associations with irritable bowel syndrome

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Abstract

Introduction and aims: Inflammatory bowel disease (IBD), including Crohn's disease (CD) and Ulcerative Colitis (UC) is often associated with high risk of malnutrition and multiple nutrient deficiencies. Dietary restrictions and modifications are common in IBD patients as an attempt to reduce gastrointestinal symptoms and improve health. These symptoms, also found in IBS patients, has been linked to dietary FODMAP intake. The evidence supporting this is growing, as clinical trials showed reduced IBS like symptoms with low FODMAP diet in IBD patients. However, Norwegian data on FODMAP content in foods is lacking. We aimed to compile FODMAP values in Norwegian foods, assess dietary intakes including FODMAPs in IBD patients and non-IBD controls, and examine the association between FODMAP in diet and IBS diagnosis in IBD patients.

Method: The FODMAP compilation was based on previous analytical publications on FODMAP content in food. We included newly diagnosed, adult IBD patients (≥18 years) from the IBSEN III study recruited between January 1st 2017 and December 31st 2019. Dietary intake data were collected using a validated semi-quantitative, digital food frequency questionnaire (FFQ).

Results: Dietary assessments were performed for a total of 779 participants with CD, UC and non-IBD controls. For both genders, intakes of saturated fat were higher, carbohydrates and vitamin D were lower, and in women iron was lower than recommended. Women with CD had higher intakes of E% from protein compared to non-IBD controls ($p=0.007$). IBD women had higher intakes of vitamin B_{12}, selenium without supplements ($p<0.05$), and fish ($p=0.007$ CD, $p=0.009$ UC) in comparison to non-IBD controls. There were no differences in FODMAP intake between the groups, nor associations between FODMAP intake and IBS diagnosis. Positive association between fructan intake ($p=0.009$) and significant more diarrhea, constipation and mixed stool ($p<0.001$, $p=0.009$ and $p<0.001$) were found in participants who made dietary changes after symptom debut.

Conclusion: The FODMAP compilation work resulted in assessment of dietary FODMAP intakes in g/day for first time in Norwegian IBD patients. Nutrient intakes were overall within recommended levels, except for vitamin D in both genders and iron in women. There were small differences between the groups, possibly due to similar dietary habits. We found no association between FODMAP intake and IBS diagnosis, but the association between fructan and IBS warrats further examination.

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Abbreviations

IBD	Irritable bowel disease
CD	Crohn's disease
UC	Ulcerative colitis
GI	Gastrointestinal
UN	United Nations
EEN	Exclusive enteral nutrition
LFD	Low FODMAP diet
FODMAP	Fermentable oligo-, di-, monosaccharides and polyols
GOS	Galactooligosaccharides
FOS	Fructooligosachharides
FGS	Functional like gastrointestinal symptoms
IBS	Irritable bowel syndrome
IBS-C	Irritable bowel syndrome- constipation
IBS-D	Irritable bowel syndrome- diarrhea
IBS-M	Irritable bowel syndrome- mixed
IBSEN III	Irritable bowel disease study of Southeastern Norway
FFQ	Food frequency questionnaire
KBS	Dietary calculation system
TSD	Services of sensitive data
USIT	University Center for Information Technology
UiO	University of Oslo
OUS	Oslo University Hospital
ANOVA	Analysis of variance
E%	Energy percent
NNR 2012	Nordic Nutrition Recommendations 2012
NCGS	Non celiac gluten sensitivity
SFA	Saturated fatty acids
MUFA	Monounsaturated fatty acids
PUFA	Polyunsaturated fatty acids
RI	Recommended intake
ECCO	European Crohn's and Colitis Organization
HPLC	High performance liquid chromatography
FHI	Public Health Institution

List of tables and figures

Tables:

Figures

Table of Contents

1 Introduction

1.1 Inflammatory bowel disease

Inflammatory bowel disease (IBD) is a collective term used to describe chronic inflammatory diseases that occur in the gastrointestinal (GI) tract (1, 2). It includes the two diagnoses, Crohn's Disease (CD) and Ulcerative colitis (UC). The epidemiological progression of IBD is complex and involves an interaction between environmental factors and specific genes in susceptible individuals (1). The majority of patients are young when diagnosed, with disease onset occurring often between age of 15 and 25 years for CD and 25 to 35 years for UC (2). IBD is often associated with high morbidity load, gradual dysfunction, in addition to expensive care costs (3).

1.1.1 Symptoms signs and treatment

Patients suffering from CD may experience episodes with symptoms like abdominal pain, watery diarrhea, fever, fatigue, and weight loss. Abdominal pain is often of a colic type and is often related to defecation. It can proceed for long periods before diagnosis along with watery diarrhea (4). Fatigue and malnutrition might be a result of malabsorption, the insufficient absorption of nutrients, which usually accompanies the inflammation. Symptoms of UC are less heterogeneous than CD. The most typical symptom is the rapid transit time diarrhea, which differs in type and severity according to the grade of inflammation (4). Inflammation located to the rectum results in mucous diarrhea, whereas watery diarrhea is caused by inflammation in the entire colon. The third type is the bloody diarrhea, which depends on the extent of inflammation and parts of the colon affected (4).

It is difficult to predict how the disease will progress or behave from one patient to another. Some can have mild symptoms with no or seldom deterioration, whereas others can suffer from more aggressive and severe inflammation (2). CD and UC differ in localization, type of inflammation, symptoms and therefore also in treatment. In CD, the inflammation can occur throughout the entire GI tract and is described as transmural, penetrating through all the layers of the intestinal wall (2, 5). It is characterized by the formation of fistulas and granulomas. UC inflammation is restricted to the mucosal and submucosal layers of the large intestines (2).The diagnostic process of IBD depends on multiple tools and tests such as imaging, endoscopy, blood and fecal tests in addition to clinical examination of the patient (2).

Several factors need to be taken into consideration when developing a treatment plan for IBD patients. This patient group is heterogeneous regarding the symptoms, disease spread, course, activity, and severity. An individualized treatment and follow-up plan, tailored to meet the specific needs of every patient is necessary to achieve disease control (2). There are two types of treatment procedures that can be initiated depending on desired result. One is the induction treatment, chosen in order to relieve an ongoing inflammation, while the maintenance treatment aims to prevent inflammation relapse (2). Surgical, biological or immounomodulating therapy as well as glucocorticoids are some treatment alternatives used during severe inflammation (2).

1.1.2 Incidence and prevalence of IBD

Both the incidence and prevalence of IBD have been increasing during the last decades in modernized countries in North America, Europe and Oceania. Recently, a rapid increase in IBD cases has also been reported in countries adopting westernized lifestyle (3). In Norway, patient registry data covering the period 1999 to 2014, showed increased prevalent cases from 88 to 185 and from 139 to 250 per 100 000 over a decade for CD and UC, respectively (6). There is no updated data on the incidence rates of IBD in Norway. The last available data from 1990-93 reported an incidence of 13.6 for UC and 5.8 for CD per 100 000 persons per year (7, 8). New data are needed, as IBD seems to be a growing challenge to global health.

1.1.3 IBD risk factors

The underlying mechanism for IBD etiology are complex and still not fully explained (3, 9-11). It involves a spectrum of risk factors including diet, smoking, pharmaceutical agents and microbiota (1). Diet is an important and modifiable environmental risk factor suggested by many studies to be associated with IBD (3, 9-11). Dietary components such as sugar, processed food, animal protein and refined carbohydrates are typically consumed in a Westernized diet. These are investigated for possible associations to inflammatory processes in the body, and thereby IBD development (3, 9, 11-13). In contrast, dietary fiber, fish, fruits and vegetables, vitamin D and polyunsaturated fatty acids are suggested to contribute to the maintenance of the guts homeostasis through different mechanisms. They are involved in microbial environment modification, immunity pathways, gut hormone production and the gut barrier function (9, 11, 12).

The diets in Europe, North America and other parts of the world adopting a westernized diet, have gone through radical changes from what previous generations usually consumed, when IBD prevalence was considered much lower (9). Switching from mostly plant-based to a more animal-based eating pattern has affected the bacterial diversity and composition of the gut, a change often seen in IBD patients (11).

1.2 Diet and IBD

Several studies have reported how IBD patients think or believe their disease might be related to the diet (14-16). Common findings from these studies point towards that a majority of IBD patients consider the diet as an effective factor, in either triggering or controlling their disease. Spicy foods together with foods rich in fiber and fat, dairy products, alcohol, and carbonated beverages are believed to worsen IBD symptoms (15, 16). Other foods were thought of as beneficial, and thus became more frequently consumed. Pro- and prebiotics, fish, nuts, and leafy vegetables are examples of foods used by patients to relieve symptoms (14). Pre- and probiotics refer to substances that are either naturally occurring in food, used as ingredients in food industry or taken as dietary supplements. Prebiotics consist of oligo- and polysaccharides (carbohydrates) that when ingested, become fermented by the microbes in the gut to yield beneficial metabolic products (17). Probiotics are live bacterial strains, which has been related to health promoting effects including maintenance of the intestinal epithelium (17). Believing that some foods worsen while others relieve symptoms, may lead IBD patients to adopt dietary restrictions or modifications (14) .

1.2.1 Dietary habits in IBD patients

In a study by Larussa et al, data showed that 70% of IBD patients modified their intakes of at least on food or food group after diagnosis (18). Exclusion of, or reduction in milk and dairy products consumption has been shown to be the most widespread change (18, 19). Total restriction of food sources rich in micronutrients such as calcium and iodine, is a risk factor for serious deficiencies. Additional deficiencies in IBD patients include iron, selenium, zinc, magnesium, water-soluble vitamins (B12 and folate most frequently) and lipid soluble vitamins A, E and K (20).

Nutritional assessment studies of IBD patients have shown that they often are underweight due to their symptoms, inflammation severity and medication use (13, 20). These symptoms are often accompanied by reduced food intake and poor appetite. In a review by Lomer et al, 5% and 7 % of 390 patients were classified at a high- and moderate risk for undernutrition, respectively (21). In contrast, data from United Nations (UN) show undernutrition rates of 0% in the general population of countries like UK, Norway, Germany among others (22). In patients with risk of undernutrition, secondary nutritional therapy aiming to support and correct malnutrition and any nutrient deficiencies is crucial (12). Consequences of malnutrition such as low bone mass and osteoporosis have been reported by Larussa et al in 51% and 15% of IBD patients, respectively (18). Furthermore, undernutrition may result in disturbances in the immune system, thereby leading to poor treatment response (23).

Nutritional advice to IBD patients should be individualized according to the disease course in every patient (12). Today, there are no defined dietary recommendations regarding specific foods, food groups or dietary patterns to induce remission or reduce inflammation in IBD patients (20). However, studies investigating different dietary treatment options such as exclusive enteral nutrition (EEN) and low FODMAP diet (LFD) are emerging and the research evidence is growing (12, 20).

1.2.2 Exclusive enteral nutrition

EEN over a period of 6-8 weeks has been used as a treatment option for pediatric patients with reported effects in CD, but not UC (11, 20). It involves giving the total daily nutritional requirements as a liquid formula, either orally or via a tube through the nose (11). Randomized controlled trials have reported remission rates ranging between 20% and 84% in acute pediatric CD, independent of disease location (20). The use of EEN in adults seems to be more challenging, due to difficult adherence to this treatment alternative. Hence, the benefits of EEN in adults are less worth considering compared to children (11). Results from meta-analyses showed weak evidence for EEN to induce remission in adults compared to placebo (11). Dietary regimens involving exclusion of one or more dietary components have been thought of as more practical for use in adults (10). Among these, the LFD has gained most attention recently.

1.2.3 FODMAP

1.2.3.1 What is FODMAP

FODMAP (fermentable oligo-, di-, monosaccharides and polyols) is an abbreviation used to describe a group of carbohydrate molecules, poorly digested or unabsorbed in the small intestine (24). Oligosaccharides are carbohydrate chains consisting of two to ten monosaccharide monomers, where fructans and galactans or galactooligosaccharides (GOS) are counted as FODMAPs (25). As indicated from the names, fructans are polymers of fructose, and galactans are made up of galactose units. Fructooligosachharides (FOS) and inulin are subgroups of fructans, and occur as the fuel storage in many plants (26, 27). They are commonly found in garlic, onion, bananas in addition to grains such as rye, wheat, barley and triticale (26, 27). Cabbage and pulses like beans and lentils are major dietary sources to GOS subtypes raffinose and stachyose (25, 28). Both FOS and inulin are widely used in the food industry as additives due to their ability to replace fat and sugar, act as emulsifiers, thickeners and stabilizers. They might also be consumed as dietary fiber supplements (29).

Lactose, or milk sugar accounts for the disaccharide part in FODMAP, mainly found in milk and other dairy products (25, 30). Exceptions are the mature cheeses, which contain negligible amounts of lactose (31). The monosaccharide fructose is not a FODMAP in its free form, unless it is present in a food item or consumed in excess of glucose (32). Typical foods containing more fructose than glucose include apple, pears, cherries, figs, honey, sugar peas and some sweet wines (33). Polyols are alcohols derived from sugars, either found as natural food constituents in fruits and vegetables or used as sweeteners to replace sugar in food production. Examples are sorbitol, mannitol, xylitol and isomalt, maltitol and lactitol (33, 34).

1.2.3.2 Malabsorption of FODMAPs

The absorption of FODMAPs in humans is poor and different mechanisms might be involved (35). The lack of enzymes needed for digestion of FOS in the human gut, makes their absorption impossible (34). The enzyme lactase is needed for lactose breakdown, and when it is missing, downregulated or insufficient, lactose intolerance occurs (34, 35). Intestinal absorption of fructose is mediated through two carrier proteins in the cells of the intestinal tract, of which one depends on co-ingestion of glucose (33). Uptake of fructose into intestinal cells is glucose independent, whereas the clearance of fructose to the blood has a limited capacity if fructose intake exceeds glucose intake (35, 36). Polyols undergo a slow and incomplete absorption, which varies according to the polyol type, the individual, ingested amount and diseases in the gastrointestinal tract. It is thought that on average, only one third of ingested amount of polyols becomes absorbed (37).

The presence of unabsorbed lactose, fructose and polyols in the highly permeable small intestine creates an osmotic effect (38). This leads to an increased amount of water in the lumen and thereby a faster transit (33, 35, 38). Fructans and GOS are less osmotically active and pass to the colon, where they act as prebiotic substrates used by colon bacteria (17, 33, 38). Bacterial fermentation of oligosaccharides increases colonic gas through the production of hydrogen and methane. These processes might cause undesired symptoms as bloating, diarrhea, abdominal pain, discomfort and flatulence in hypersensitive people, often called functional like gastrointestinal symptoms (FGS) (35).

1.2.4 Low FODMAP diet

1.2.4.1 IBS and low FODMAP diet

FGS are present as irritable bowel syndrome (IBS) in approximately 11% of adults in the general population (35, 39). Using dietary therapy in patients with IBS has gained much attention, as the evidence supporting it is increasing (40). A reduction in FODMAP intake, or the LFD, basically involves two phases, the restriction and systematic re-introduction (35, 39). Results from both observational and intervention studies show symptom improvements in 50-80% of IBS patients after a LFD (35, 39). This resulted in the incorporation of the LFD in the IBS management guidelines (35).

The definition of IBS as a diagnosis might be challenging due to its diffuse symptoms and the lack of established diagnostic tests (41, 42). Multiple IBS diagnostic criteria has been developed historically, starting in 1978 and updated lastly in 2016, as the ROME IV criteria (42). ROME IV criteria identify IBS according to repetitive episodes of abdominal pain along with its relation to fecal changes. The IBS diagnosis is set if patients suffer from abdominal pain for a minimum of three times a week, during the previous three months. Additionally, two out of three fecal related criteria should be fulfilled. The dominant stool type is further used as in the sub classification of IBS into IBS-C (constipation), IBS-D (diarrhea), IBS-M (mix) or IBS, unsubtyped (42). An overview of the ROME IV criteria is given in Appendix 1.

1.2.4.2 Low FODMAP diet and IBD

As much as 35-40% of IBD patients in remission or with inactive IBD experience bowel related symptoms (43, 44). Patients with IBD may in addition to their disease have a coexisting IBS, which negatively impact their quality of life (44). A large cohort study found lactose intolerance and fructose malabsorption in more than 40% and 61% of patients with CD and UC, respectively, compared to half the frequency in controls (45). Several clinical studies have investigated the impact of a LFD on functional gastrointestinal symptoms, quality of life and disease activity in IBD patients (35, 43, 44, 46-49).

Following a period of 3-12 weeks with LFD, patients reported improvements in their bowel related symptoms and a reduction in disease activity (35, 43, 44, 46, 47, 49). However, findings regarding effects on the health related quality of life scores and inflammatory markers were contradicting (43, 44, 46-48). Prince et al and Maagaard et al also found that a higher proportion of IBD patients described their stool as more normal after the LFD period, both in frequency and consistency (35, 49). According to these findings, alteration of FODMAP quantity in the diet may be beneficial and useful as part of the total management plan of IBD.

1.2.4.3 FODMAP content in Norwegian food

Inclusion of diet or dietary advice in the treatment plan of IBD depends on valid and accurate sources to FODMAP quantity in different foods and beverages. The University of Monash has already conducted FODMAP analyses in a large sample of Australian food and beverages (32). As the evidence supporting use of FODMAP diet is increasing, more country specific FODMAP data are needed. Knowledge about which foods contain FODMAPs and in which amount can help in implementation of a less restrictive LFD, which ensures nutritional adequacy. Furthermore, acceptability of the diet amongst patients is also important considering the cultural and personal preferences (32). Country specific FODMAP values are necessary, because the FODMAP content of food may vary with its origin and frequency of use (32). Data on FODMAP content in Norwegian foods are sparse, as the Norwegian food database (50) does not contain FODMAP values. Thus, there is a knowledge gap regarding FODMAP content of foods in the Norwegian diet.

1.3 Dietary assessment

Evaluating or surveying the dietary intake of food and nutrients in a group of people relies on dietary data collection through the use of valid dietary assessment tools (51). Dietary assessment tools can be categorized based on type, record time or purpose. They can either collect dietary data at the consumer level (direct), or indirectly using food import/export statistics. Retrospective methods refer to methods assessing dietary intakes back in time, such as 24 hours dietary recall and food frequency questionnaires (FFQs). In contrast, in prospective methods the food consumed are registered at time of consumption. Examples include the weighed record and food diary (51).

1.3.1 Food frequency questionnaire

From its name, FFQs assess the frequency of foods consumed over a predefined period of time such as a week, month or a whole year (51). It often includes a list of determined foods to be measured, in addition to the frequency component. Most FFQs are considered as semi-quantitative, allowing for estimation of consumed food by incorporation of portion sizes or food amounts in addition to frequency. Today, there are both paper- and web-based FFQs that might be either self-administered or applied via an interviewer (51).

FFQs are mainly used in epidemiological studies assessing dietary intakes in large population groups (51). It is time saving and easy to apply, resulting in simple data transfer. These advantages make FFQ more suitable for use in large population studies compared to other dietary assessment methods. FFQs should be designed and validated specifically for the populations in which they are intended to be used in (51).

1.4 The IBSEN III study

The IBSEN III (Inflammatory bowel disease in Southeastern Norway) study is a population based study, with an observational, prospective cohort design that aims to investigate the incidence of IBD and its relationship to environmental and socioeconomic factors, including diet. The IBSEN III study is the third study investigating IBD in Norway. The original IBSEN study was performed in the period 1990-93, followed by the IBSEN II in 2005-07. There are many research groups from different research fields involved in the IBSEN III study such as epidemiology, microbiota and immunology, diet and genetics (52).

This master thesis includes a large cohort of newly diagnosed IBD patients (CD & UC), in addition to a non IBD control group, recruited in the IBSEN III study. In 2019, a master thesis at the Department of Nutrition investigated the diet of a sub-population of the IBSEN III study (53). In this master thesis, both the dietary and FODMAP intake as well as IBS diagnosis related to FODMAP consumption in the IBSEN III IBD population in Norway, are described in detail.

2 Aims

The overall aim of this master thesis was to collect information about dietary intake in a population of newly diagnosed IBD patients in Norway, including the intake of FODMAPs, and to investigate the association between FODMAP intake and IBS diagnosis in IBD patients.

Specific aims:

- To compile FODMAP values for the food items found in the FFQ used in IBSEN III study.
- To compare dietary intake of macro-, micronutrients and food groups in IBD patients (CD & UC) and controls.
- To describe the diet of CD and UC patients in relation to the dietary recommendations in Norway, and intakes in the general population reported in Norkost 3.
- To describe the intake of FODMAPs in IBD patients (CD & UC) and controls, and assess the FODMAP quantity obtained from different food groups.
- Investigate if FODMAP quantity in the diet is associated with IBS diagnosis in IBD patients.

3 Methods

3.1 Compilation of FODMAP values

In this master thesis, FODMAP data was compiled as grams/100 g of food from available research papers.

3.1.1 Literature search

The search sessions were performed using multiple terms for individual and total FODMAPs combined with terms for food and beverages. A complete list over used search terms is given in Appendix 2. The literature searches were performed in the period 15th August-10th December 2020.

When no publications were obtained for a FODMAP or a food group, a more specific and detailed search was conducted for a single food item or a FODMAP subgroup (fructans in vegetables, fructose in fruits, fructans in nuts, polyols in fruit, fructose in honey etc.) A detailed list of used search terms is given in Appendix 2. The searching engines PubMed, Semantic Scholar and Google Scholar were used. The national food databases of Norway (50), Finland (54) and Australian Food Composition Database (55) were used to check carbohydrate and dietary fiber content in meat, poultry, fish, milk and dairy products and beverages (50, 54, 55). Database from Finland was utilized due to the similar products as those found in the Norwegian database. The food database for Australia-New Zealand contained additional values for lactose, fructose and polyols. Additionally, some web-pages from industrial companies such as Tine, Fun light, Natreen and Q-meieriene were used in order to define ingredients in their products (56-61).

3.1.2 Inclusion of articles

All abstracts were screened in order to identify which articles to be included for the full reading step. Both original analytical and non-analytical research papers were included. After full text reading, the following eligibility criteria were used for final inclusion:

- FODMAP measured/reported primarily as gram per 100 g of food (or 100 mL for beverages)
    - Other units accepted (µg, mg, kg), and recalculated to g/100 g
- Fresh weight of sample used in measurement (unless for cereals, where dry weight was mostly used)
- No duplicates

3.1.3 Compilation of FODMAP values

Firstly, food items and dishes in the FFQ applied in IBSEN III (see paragraph 3.2.4.1 for FFQ description), were given a value for total FODMAP content and the five FODMAP subgroups (excess fructose to glucose, lactose, polyols, total fructans and GOS). Every food item was assigned FODMAP values based on compiled values from the articles included through the literature search (Appendix 3). Total FODMAP was calculated as the sum of all FODMAP subgroups.

Foods representing either a raw food, single item or a recipe ingredient were assigned FODMAP values first. The points below were taken into consideration before adopting any value.

- If only one value was found for a FODMAP subgroup for a food item, that value was adopted.

- When multiple values were available, the mean was calculated.
- Lactose content in milk and dairy products was mainly obtained through the Norwegian food database. Finnish and Australian food databases were used in case of missing information.
- Food items with no dietary fiber content, was given a null value for fructans and GOS.
- The Australian food database was the source of polyol values, unless other published data was available.

All the obtained values for single food items were imported in to the food composition and calculation system at the Department of Nutrition, KBS (Kost Beregnings System), where FODMAP values for composite dishes and recipes were automatically calculated. All missing food codes for recipes were then identified so that a full and complete estimation of FODMAP for all codes in the FFQ was fulfilled. The compilation of FODMAP values was done according to the guidelines of food composition databases compilation by Greenfield and Southgate (62).

3.2 IBSEN III, recruitment process, study population and data collection

3.2.1 Recruitment process

In the IBSEN III study, 2252 participants with signed consents were included in the period from January 1st, 2017 to December 31st, 2019. The recruitment process was carried out in local- and university hospitals from the South Eastern Health region in Norway.

All participants included in the IBSEN III study will be followed-up prospectively, for a period of five years (52). A new round of data collection is initiated at year 1 and 5 of follow-up. A wide range of demographic and clinical data, including dietary data will then be gathered.

The IBSEN III study is registered at clinicaltrials.gov with the number NCT02727959 (63) . The current master thesis investigates the baseline dietary data collected from the IBSEN III study.

3.2.2 Study population

The IBSEN III study included patients with newly diagnosed and untreated IBD, either CD or UC of all ages and both genders. The controls are non-IBD persons that had suspected symptoms to IBD, but without any examinational findings (63). Participants were included from nine counties in Southeastern Norway (Oslo, Akershus, Buskerud, Hedmark, Østfold, Vestfold, Telemark, Østfold, Aust- and Vest Agder), which made up a total population of 2.854.217 persons per January 2014 (52).

The recruitment process was initiated through the general practitioners, who should forward all patients with IBD suspicious symptoms to the local hospitals (52). At the hospitals, patients were invited to participate in the study prior to any diagnostic procedure.

Summarized eligibility criteria for IBSEN III study are described below. The detailed diagnostic criteria for CD and UC according to Lennard-Jones (64) are listed in Appendix 4.

Inclusion criteria

- Ulcerative Colitis
- Crohn's disease

Exclusion criteria

- Other causes of acute or chronic bowel inflammation must be excluded, i.e., infectious colitis, radiation colitis, diversion colitis, solitary rectal ulcer syndrome, graft versus host disease, diverticular colitis, medication associated colitis, ischemic colitis, microscopic colitis and enema associated colitis.
- Refusal or inability to give informed consent.

In this master thesis, we included all IBD patients and non-IBD controls over 18 years of age, with a signed consent and complete dietary FFQ at inclusion.

3.2.3 Demographic and clinical variables

The demographic variables include marital status, work, educational level, age at diagnosis, smoking, Swedish snus use, and physical activity. These were collected through a questionnaire answered by the patients. Closed questions were predominantly used with answers either chosen from multiple categories or as yes/no (Appendix 5). This questionnaire has not been validated before application.

The variables weight and height were collected during the clinical examination by heath personnel, and further used for body mass index (BMI) calculation as kg/m^2. Patient reported questionnaires were used in order to obtain information about symptom duration until consultation, pre- and probiotics (Appendix 6), use of any elimination diet (Appendix 6), and IBS diagnosis (abdominal pain and stool type, frequency etc.). The ROME IV criteria used as the IBS diagnostic tool in the IBSEN III study has been validated previously (65).

3.2.4 Dietary data

At inclusion, the participants were asked to fill in an online FFQ developed, extended and evaluated at the Department of Nutrition at the University of Oslo (UiO) (66). Originally, this semi-quantitative food questionnaire was used in the Norwegian national survey Norkost in 1997. Since then, and in several steps, the FFQ has been revised, updated and digitalized for usage in several clinical trials, including the IBSEN III study.

3.2.4.1 The online FFQ

The FFQ was developed in order to be used as an assessment of the participants' habitual dietary intake during the previous 12 months. There are different ways to access the questionnaire, either through UiO's webpage, via a link in Viedoc or a link from the participant folder. To open the questionnaire, participants had to log in using their bank identification linked to the Norwegian National Identity number. Using this method helped to identify and recall every participant in a secure way. All the data has been stored in the services of sensitive data (TSD), which is a databank at the University center for Information Technology (USIT) at UiO.

In the online FFQ, there are 269 questions about food items and meals, subdivided into 25 different groups, according to similarity or relationship between food items. Questions used in the FFQ target both the type, quantity and frequency of intake (Appendix 7) (66). To make it easier for the participants to answer the questions, images of portion sizes, measures in household units (spoons, cups, glasses, slices) and different frequency options were used. Frequencies of consumption ranged from multiple times per day to seldom or never (66).

3.2.5 Estimation of dietary intake

The food database AE-18 was used for the estimation of intake of energy, macro-, micronutrients, food groups (g/day) and individual and total FODMAPs (g/day), based on intakes from the FFQ. This database is part of the food composition and calculation system (KBS 7.4), previously mentioned. For micronutrients, the estimation of intake was performed with and without dietary supplements. Different food group's contribution to the FODMAP intake was also estimated.

3.3 Ethics

The Regional Committee for Medical and Health Research Ethics, REC Southeast Norway has given the ethical approval to the IBSEN III study (REC number: 2015/946). All participants signed a written consent as an agreement to participation. This master project was approved by REC in an amendment to the original application (ref. 27860; 7.10.2020).

3.4 Matching and preparation of data

The dietary assessment part of the IBSEN III study was organized and conducted in a collaboration between the Oslo University Hospital (OUS) and the Department of Nutrition, UiO. The Department of Nutrition was responsible for the assessment, storage and analysis of dietary data. When a participant completed filling in the FFQ, the dietary data was automatically stored in TSD at UiO. Thus, the background and clinical data from the OUS storage area had to be matched to the dietary data before further analyses.

Dietary data were after completion of the FFQ, exported from TSD and imported to KBS to calculate intakes of food, energy, macro- and micronutrients and FODMAP. The new recalculated data were subsequently transferred into TSD and matched with the background and clinical variables, via a pre-designed project key and the Norwegian National identity number. Originally, 981 participants completed dietary FFQ at inclusion, whereas background data were available for 2252 participants. In order to end up with the correct data set, some data preparation steps were performed; exclusion of participants with missing data, exclusion of those <18 years, exclusion of participants with no IBD and who were not included as non-IBD controls and exclusion participants with unrealistic energy reporting.

Energy misreporting in participants was evaluated according to cut-offs for energy under-, and over reporting, identified from previously published papers that assessed energy intake in IBD patients (67-69). As stated by these studies, energy intake in the IBD population was equivalent to the normal population. Accordingly, we chose to exclude any participant with energy intake less than 3000 or more than 20 000 KJ/day.

3.5 Statistical analysis

The program IBM SPSS Statistics, version 27 was used to perform the statistical analyses. For categorical variables, frequencies with proportions were presented and chi-squared test was used for comparison between groups. Evaluations of data distribution were made for continuous outcomes using the Q-Q plots, histograms, mean and median. Normal distributed data were presented as mean with 95% confidence interval (95% CI), whereas median with percentiles (25^{th} and 75^{th}) were used for data with skewed distribution. Mean with standard deviation (SD) was chosen as presentation alternative in the comparisons to the Norkost 3.

To compare the results across the three groups (CD, UC and non-IBD controls), the one way analysis of variance (ANOVA) was used. Further, to identify between-group variations, when significant with ANOVA, Student's t-test and Mann Whitney U test were used. These tests were also used in two-group comparisons. The Student's t-test was applied for normal distributed data and Mann-Whitney U test for skewed data.

In order to investigate any association between FODMAP intake and IBS in IBD patients, two logistic regression analyses was carried out. One was including IBS diagnosis (categorized as IBS, no IBS) was chosen as the dependent variable and FODMAP intake (continuous) as the independent. The adjusted model included the covariates gender, smoking (categorized as yes or no), age (continuous), diagnosis (categorized in UC or CD using dummy variables), the use of pre- and probiotics (categorized in yes or no), and dietary changes (categorized in yes/no).

A second analysis was conducted on the same way as the first, but involved separating the sample in those who made dietary changes after symptom debut versus those with no changes. The odds ratios (ORs) with 95% CIs were obtained for both analyses. The adjusted model included the same covariates as the first analysis, except for dietary changes.

Another regression analysis was performed to study any associations between dietary changes and the prevalence of different stool types. Dietary changes (categorized as yes/no) was chosen as dependent variable and stool type (categorized as diarrhea, constipation and mix using dummy variables). Only p-values were adopted with no adjustments used. Statistical significance was considered at a two- sided p-value below 0.05.

4 Results

4.1 Compilation of FODMAP values in food items

The literature search originally identified **68** articles with FODMAP data. After abstract screening and full text reading, **42** articles were included in FODMAP data extraction. The articles identified and included have been published during a period of forty years, from 1980 (Makinen et al.) to 2020 (Ispiryan et al.). FODMAP values presented in the articles included subgroups of FODMAP in different food items. **Table 1** summarizes the utilized publications in the FODMAP value estimation for single food items.

Table 1. Included articles used for FODMAP values compilation with types of food and FODMAP reported.

Publication	Type of FODMAP	Foods reported
Aprea et al, 2017 (70)	Excess fructose & polyols	Apples
Biesiekierski et al, 2011 (28)	All FODMAPs	Grains, breakfast cereals, bread, pulses & biscuits
Bogdnov et al, 2008[1] (71)	Excess fructose	Honey
Camire et al, 2003 (72)	Fructans	Raisins
Campbell et al, 1997 (73)	FOS	Fruits & vegetables
Cekic et al, 2010 (74)	Excess fructose	Raspberries
Chareoansiri et al, 2009 (75)	Excess fructose	Fruits
Chinnici et al, 2005 (76)	Excess fructose	Fruit juices
Chumpiatzi et al, 2018 (77)	All FODMAPs	Different foods
de la Fuente et al, 2011 (78)	Excess fructose, GOS & FOS	Honey
Dominiguez et al, 2016 (79)	Excess fructose	Honey
Griffin et al, 2017 (80)	Excess fructose & GOS	Cashew nuts
Haskå et al, 2008 (81)	Fructans	Wheat
Henry et al, 1989 (82)	Excess fructose, GOS & FOS	Cereals
Hernandez-Hernandez et al, 2011 (83)	Excess fructose & GOS	Vegetables
Hogarth et al, 2000 (84)	FOS	Different foods
Ispiryan et al, 2019 (85)	Fructans	Cereals
Ispiryan et al, 2020 (86)	Excess fructose, polyols, fructans & GOS	Cereal products
Jovanovic-Malinovska et al, 2014 (87)	Excess fructose, polyols, FOS & GOS	Fruits & vegetables
Judprasong et al, 2011 (88)	Fructans	Different foods
Kamal-Eldin et al, 2009 (89)	Fructans	Grains
Karppinen et al, 2003 (90)	Fructans	Rye
Koh et al, 2018 (91)	Excess fructose, polyols & lactose	Candy & sweets
Li et al, 2002 (92)	Excess fructose	Different foods
Ma et al, 2014 (93)	Excess fructose, polyols	Fruits
Makinen et al, 1980 (94)	Polyols	Fruits & berries
Martin-Villa et al, 1982 (95)	Excess fructose	Vegetables

Mikulic-Petkovsek et al, 2012 (96)	Excess fructose & polyols	Berries
Milivojevic et al, 2011 (97)	Excess fructose	Berries
Muir et al, 2007 (98)	Fructans	Fruits & vegetables
Muir et al, 2009 (99)	Excess fructose, polyols, GOS & FOS	Fruits & vegetables
Ruiz-Aceituno et al, 2012 (100)	Excess fructose & GOS	Pine nuts
Shalini et al, 2015 (101)	Fructans	Banana
Shanmugavelan et al, 2013 (102)	Excess fructose, lactose & GOS	Different foods
Stacewicz et al, 2001[1] (103)	Excess fructose & polyols	Prunes
Van Loo et al, 1995 (104)	Fructans	Different foods
Varo et al, 1984a (105)	Excess fructose	Cereals
Varo et al, 1984b (106)	Excess fructose	Fruits & vegetables
Vidal-Valverde et al, 1985 (107)	Excess fructose	Beverages
Wrolstad et al, 1981[1] (108)	Excess fructose & polyols	Fruits
Yao et al, 2014 (109)	Polyols	Different foods
Ziegler et al, 2016 (110)	Excess fructose, fructans & GOS	Grains & cereals

FOS: fructooligosaccharides, GOS: galactooligosaccharides, [1] non analysis publication.

All food items in the IBSEN III FFQ were given a FODMAP value. An overview of the amount of FODMAP subgroups as well as total FODMAP for all food items and compound dishes included in the IBSEN III FFQ is given in Appendix 8.

4.2 Demographic and clinical characteristics of participants

The flow chart below (**Figure 1**) shows the detailed selection process of participants included in this master thesis. From 2252 participants originally included in IBSEN III (626 CD & 1080 UC), 779 (35%) were included. These were >18 years, had completed the dietary FFQ had either CD or UC diagnosis, or were non-IBD controls. Among the participants excluded due to unrealistic energy intake, 3 were considered as under-reporters and 50 as over-reporters.

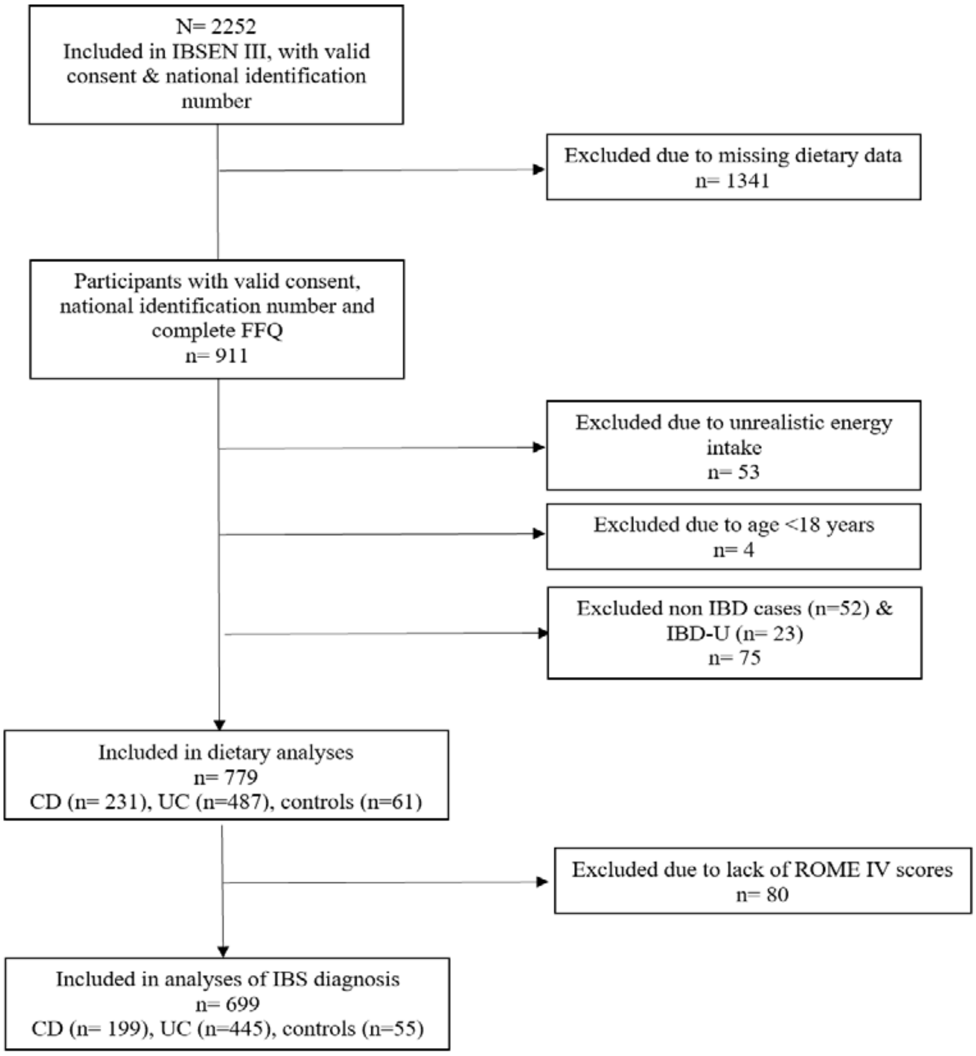

Figure 1. Flow chart of the sample size included in this master thesis. IBSEN: Inflammatory bowel disease in Southeastern Norway, IBD-U: IBD-unclassified, CD: Crohn's disease, UC: Ulcerative Colitis, ROME IV: diagnostic criteria for Irritable bowel syndrome (IBS).

The background characteristics of the study sample are presented in **Table 2**. There were more women than men in the CD group (61%, p=0.001), but not the UC group (51%, p=0.56).

The age in the study population ranged from 18-82 years, with a mean age of 41 years among CD patients, and 38 and 42 years in UC women and men, respectively (see **Table 2**). Women with IBD were significantly older than women in the control group. BMI was in the upper normal range, with no difference between the two disease groups and the non-IBD controls for both genders. Furthermore, we observed that 18 participants (of these 22% CD and 78% UC) with IBD had a BMI <18.5 kg/m², and 322 (of these 33% CD and 67% UC) with a BMI>25 kg/m².

Table 2. Demographic, background and clinical characteristics of IBD patients and controls at inclusion.

	Women				Men			
	CD (n=140)	**UC (n=250)**	**Controls (n= 42)**	**p-value**	**CD (n=91)**	**UC (n=237)**	**Controls (n=19)**	**p-value**
Age, years[2]	41 [38-43]	38 [36-40]	33 [29-37]	**0.01** **0.006[b]#** **0.04[c]#**	41 [38-44]	42 [40-44]	38 [31-46]	0.59
Weight[3], kg	73 [70-76]	70 [68-71]	72 [65, 79]	0.13	83 [80-87]	84 [82-86]	87 [81-92]	0.67
Height[3], cm[3]	167 [166-168]	168 [167-169]	167 [164-169]	0.45	181 [180-183]	181 [181-182]	181 [178-184]	0.97
BMI[3], kg/m²	26 [25-27]	25 [24-25]	26 [24-28]	0.06	25 [24-26]	26 [25-26]	27 [24-29]	0.47
Marital status[4]				0.42†				0.92†
Married/partner (%)	92 (68)	163 (68)	23 (57)		59 (69)	150 (66)	14 (74)	
Single (%)	37 (27)	63 (26)	15 (38)		23 (27)	66 (29)	4 (21)	
Widow (%)	1 (1)	1 (1)	0		0	2 (1)	0	
Divorced (%)	6 (4)	12 (5)	2 (5)		3 (4)	9 (4)	1 (5)	
Educational level[4]				0.89†				0.21†
≤13 years (%)	63 (46)	103 (43)	20 (49)		41 (48)	112 (50)	5 (26)	
>13 years (%)	73 (54)	139 (57)	21 (51)		44 (52)	112 (50)	14 (74)	
Tobacco[5]								
Smoking (%)	26 (19)	20 (8)	8 (19)	**0.002[a]†** 0.95[b]† **0.03[c]†**	14 (15)	24 (10)	2 (10)	0.35†
Swedish snus (%)	14 (10)	45 (18)	12 (29)	**0.03[a]†** **0.003[b]†** 0.11[c]†	24 (26)	72 (30)	3 (16)	0.32†
PA before diagnosis[6]				0.53†				0.61†
Daily (%)	52 (38)	112 (47)	17 (41)		27 (32)	92 (41)	8 (42)	
Weekly (%)	58 (43)	95 (39)	18 (44)		38 (45)	94 (41)	8 (42)	
Seldom than weekly (%)	26 (19)	34 (14)	6 (15)		20 (23)	40 (18)	3 (16)	
PA after diagnosis[7]				0.59†				0.77†
Daily (%)	37 (27)	80 (33)	12 (29)		22 (26)	76 (34)	6 (32)	
Weekly (%)	57 (42)	98 (41)	20 (49)		39 (46)	94 (41)	9 (47)	
Seldom than weekly (%)	42 (31)	63 (26)	9 (22)		23 (28)	56 (25)	4 (21)	

Symptom duration before consultation, months[3]	10 (4, 25)[1]	5 (3, 9)[1]	9 (4, 24)[1]	**<0.001 <0.001[ac]##**	8 (3, 24)[1]	4 (2, 9)[1]	9 (4, 12)[1]	**<0.001 <0.001[a] 0.01[c]**

#tested using independent samples t-test, ## tested using Mann-Whitney U test. † tested using Chi- squared test. Other p-values obtained using one way ANOVA. Data presented as mean [95 % CI]. [1] Data presented as median (25, 75 percentiles), [2] age (n=768), [3] weight, height, BMI, symptom duration (n=764), [4]Marital status & educational level (n=746), [5]Tobacco (n=750), [6]PA before diagnosis (n=748), [7]PA after diagnosis (n=747), [a]p-value between CD & UC, [b]p-value between CD & controls, [c]p-value between UC & controls. CD: Crohn's disease, UC: Ulcerative colitis, , BMI: body mass index, PA: physical activity.

More than 90% of IBD patients were married or had a partner, and more than half of them had a high educational level (>13 years). Both women with CD and women in the control group smoked more than women with UC ($p<0.001$). There was significantly more Swedish snus users among women in the control group and women with UC compared to women with CD ($p=0.03$ and 0.003, respectively).

As many as 146 CD patients (63%) and 326 UC patients (67%) with dietary data were diagnosed prior to their inclusion in the IBSEN III study.

4.3 Dietary intakes in IBD patients

4.3.1 Response rate to dietary FFQ

The response rate to dietary FFQ was 41%. A total of 911 participants out of 2251, with signed consent and national identity number completed the dietary FFQ, where 411 (45%) were men and 500 (55%) women. In women, 238 (48%) participants were in the age group 18-34 years, where 44% had higher educational level and were non-smokers. There were 761 participants diagnosed with IBD (249 CD and 512 UC). More females with CD (60%) completed the FFQ compared to women with UC (51%), and more men with UC (49%) compared to men with CD (40%).

4.3.2 Energy and macronutrients

Dietary intakes in the groups are presented in **Table 3**. Except for higher energy percent (E %) from protein in women with CD compared with women in the control group ($p=0.007$), there were no differences in energy and macronutrient intake between CD, UC and non-IBD controls.

4.3.3 Micronutrients

No significant differences in intakes of micronutrients including or excluding supplements were found across the disease and control groups for men (**Table 4**). In women however, when estimated without supplements, IBD patients had a higher intake of vitamin B_{12} and selenium compared to non-IBD controls ($p<0.05$). When supplements were included, intake of vitamin B_{12} was still significantly higher in women with IBD compared to women in the control group.

4.3.4 Macro-, and micronutrient intake in IBD patients compared to Norwegian recommendations and Norkost 3

As given in **Tables 5 and 6**, IBD patients had similar E% from macronutrients, as the general population from the Noskost 3 survey, except for intake of alcohol, which was lower in men and women with IBD compared to the general population (a difference of 0.8 E%). The intake of most macronutrients was within the recommended levels, except for E% from saturated fatty acids and carbohydrates. The first was higher than recommended (13 E%) than recommended level <10 E%, while the latter was lower (43 E%) than the lowest recommended level of 45 E%.

Intakes of selected micronutrients in IBD patients were higher compared to healthy Norwegian adults in the Norkost 3 survey (111). The mean intakes of thiamin, riboflavin, vitamin B_6, folate, vitamin B_{12}, vitamin C, calcium, zinc, selenium and iodine were within recommendations for both genders. However, for vitamin D in both genders with IBD (7.4 and 8 µg in women and men, respectively) and iron in women with IBD (11 mg/day), the intakes were below recommendations.

A varying number IBD patients had micronutrient intakes <RI for vitamin D, thiamin, riboflavin, folate, vitamin B_6, vitamin C, calcium, iron, zinc selenium and iodine in both genders (**Figures 2 & 3**). This was regardless of supplemental use, however, a higher share of participants were within recommendations when supplements were included in the estimation. We stratified the intakes of vitamin D, folate and iron in women according to age, due to different recommendations for different age groups in the NNR 2012 (112).

4.3.5 Consumption of different food groups

No statistical differences were observed for intake of different food groups between the disease groups and controls for both genders (**Table 7**). The only exception was the intake of fish and shellfish, which was higher in women with CD and UC compared to women in the control group (p=0.007 and p=0.009, respectively). Twenty-eight IBD patients (4%) and 6 non-IBD controls (10%) had no fish intake. Five non-IBD controls (8%) and 47 IBD patients (6%) reported to have no meat intake, of whom women represented more than two thirds of them (n=31).

Table 3. Daily intake of energy and macronutrients in gram/day and E% of total energy in CD, UC and controls.

	Women				Men			
	CD (n=140)	UC (n=250)	Controls (n=42)	p-value	CD (n=91)	UC (n=237)	Controls (n=19)	p-value
Energy, MJ/day	9.0 [8.8-10]	10 [9.0-10]	9.1 [8.1-10]	0.55	12 [11-13]	12 [11-12]	12 [11-13]	0.52
Protein, g/day	96 [89-105]	95 [91-100]	85 [75-95]	0.27	121 [112-129]	115 [110-119]	125 [111-139]	0.21
Fat, g/day	92 [86-98]	96 [91-101]	88 [77-100]	0.37	121 [112-131]	114 [109-120]	119 [102-135]	0.37
SFA, g/day	33 [30-35]	35 [33-37]	32 [28-36]	0.37	44 [41-48]	43 [40-45]	43 [36-49]	0.67
MUFA, g/day	35 [32-37]	36 [34-39]	33 [29-38]	0.36	46 [42-50]	43 [40-45]	44 [38-51]	0.32
PUFA, g/day	16 [15-18]	17 [16-18]	16 [13-18]	0.19	21 [19-23]	19 [10-20]	21 [18-25]	0.70
Omega 3, g/day	4.0 [3.5-4.3]	4.0 [3.6-4.2]	3.4 [2.9-3.9]	0.43	4.6 [4.1-5.1]	4.3 [4.0-5.0]	5.0 [3.7-6.2]	0.33
Omega 6, g/day	13 [12-14]	13 [12-14]	13 [10-15]	0.96	16 [15-18]	15 [14-16]	16 [14-19]	0.17
Carbohydrates, g/day	237 [221-252]	242 [230-254]	300 [257-330]	0.81	307 [284-330]	299 [286-312]	299 [286-312]	0.86
Dietary fiber, g/day	29 [27-31]	30 [28-31]	31 [29-34]	0.58	31 [29-34]	29 [28-31]	29 [28-31]	0.18
Added sugar, g/day	31 (16, 51)[1]	31 (19, 53)[1]	37 (23, 49)[1]	0.47	41 (28, 75)[1]	40 (23, 75)[1]	53 (28, 65)[1]	0.94
Alcohol, g/day	1.6 (0.5, 3.9)[1]	2.3 (0.6, 5.4)[1]	2.3 (0.6, 8.2)[1]	0.12	4.0 (0.7, 9.0)[1]	4.3 (1.8, 9.4)[1]	3.5 (0.6, 8.2)[1]	0.60
Protein, E %	17.7 [17.0-18.1]	16.9 [16.6-17.3]	16.0 [15.1-16.9]	**0.01 0.007[a]#**	16.9 [16.3-17.6]	16.8 [16.5-17.2]	17.9 [16.7-19.1]	0.28
Fat, E%	36.2 [35.2-37.1]	36.4 [35.6-37.2]	35.4 [33.6-37.3]	0.61	36.6 [35.3-38.0]	35.8 [35.0-36.7]	36.2 [34.3-38.1]	0.59
SFA, E %	12.9 [12.4-13.3]	13.1 [12.7-13.5]	12.9 [12.1-13.6]	0.65	13.4 [12.8-14.0]	13.2 [12.9-13.6]	13.0 [11.7-14.3]	0.84
MUFA, E %	13.6 [13.2-14.1]	13.8 [13.5-14.2]	13.3 [12.6-14.1]	0.53	13.8 [13.1-14.5]	13.4 [13.0-13.8]	13.6 [12.7-14.4]	0.55
PUFA, E %	6.5 [6.2-6.8]	6.3 [6.1-6.5]	6.2 [5.6-6.9]	0.48	6.3 [6.0-6.7]	6.0 [5.8-6.3]	6.0 [5.8-6.3]	0.44
Carbohydrates, E%	42.7 [41.6-43.9]	42.7 [41.7-43.7]	44.7 [42.8-46.6]	0.26	42.7 [41.6-43.9]	42.7 [41.7-43.7]	44.7 [42.8-46.6]	0.60
Dietary fiber, E %	2.5 [2.4-2.6]	2.5 [2.4-2.6]	2.4 [2.2-2.6]	0.76	2.0 [1.9-2.2]	2.0 [1.9-2.1]	2.2 [1.9-2.5]	0.56
Added sugar, E % #	5.8 (3.3, 8.9)[1]	6.1 (3.8, 9.6)[1]	7.0 (4.8, 10.6)[1]	0.24	6.1 (4.5, 9.2)[1]	6.3 (3.5, 9.8)[1]	6.7 (4.9, 8.3)[1]	0.73
Alcohol, E %	0.5 (0.1, 1.2)[1]	0.7 (0.2, 1.6)[1]	0.7 (0.2, 2.5)[1]	0.25	1.0 (0.2, 2.3)[1]	1.2 (0.5, 3.0)[1]	0.7 (0.1, 2.0)[1]	0.55

#tested using independent samples t-test, all other p-values obtained using one way ANOVA. Data presented as mean [95% CI], [1] data presented as median (25, 75 percentiles), [a]p-value between CD & controls. CD: Crohn's disease, UC: Ulcerative colitis, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids, E %: energy percent.

Table 4. Daily intake of micronutrients excluding and including supplements in the different groups.

	Women				Men			
Without supplements	**CD (n=140)**	**UC (n=250)**	**Controls (n=42)**	**p-value**	**CD (n=91)**	**UC (n=237)**	**Controls (n=19)**	**p-value**
Vitamin A, µg/day	1181 [1069-1293]	1151 [1070-1232]	1083 [914-1252]	0.69	1267 [1115-1419]	1252 [1161-1344]	1365 [1107-1623]	0.80
Vitamin D, µg/day	7.4 [6.7-8.1]	7.4 [6.9-7.9]	6.3 [5.3-7.4]	0.29	8.9 [7.9-9.9]	8.3 [7.9-8.8]	10 [7.5-13]	0.09
Vitamin E, mg/day	15 [14-16]	16 [15-17]	15 [12-17]	0.32	18 [17-20]	17 [16-18]	19 [16-22]	0.41
Thiamin, mg/day	1.6 [1.5-1.7]	1.6 [1.5-1.7]	1.5 [1.3-1.7]	0.43	2.0 [1.9, 2.1]	1.9 [1.8, 2.0]	2.0 [1.8, 2.3]	0.52
Riboflavin, mg/day	1.9 [1.8-2.1]	2.0 [1.9-2.1]	1.7 [1.4-2.0]	0.11	2.4 [2.2, 2.6]	2.4 [2.3, 2.5]	2.4 [2.1, 2.7]	0.84
Niacin, mg/day	24 [22-26]	23 [22-25]	21 [19-24]	0.31	31 [28-33]	29 [27-30]	32 [28-36]	0.12
Vitamin B_6, mg/day	2.0 [1.8-2.1]	1.9 [1.8-2.0]	1.7 [1.5-1.9]	0.16	2.2 [2.0, 2.4]	2.0 [1.9, 2.1]	2.4 [2.1, 2.7]	0.06
Folate, µg/day	341 [317-367]	346 [328-365]	302 [258-345]	0.20	366 [337-395]	346 [331-361]	391 [337-444]	0.18
Vitamin B_{12}, µg/day	6.9 [6.4-7.6]	6.8 [6.4-7.2]	5.3 [4.6-6.1]	**0.02** **0.001[a]#** **0.001[b]#**	8.5 [7.7, 9.3]	8.2 [7.8, 8.7]	9.2 [7.4, 11]	0.45
Vitamin C, mg/day	152 [134-170]	153 [141-166]	127 [105-150]	0.28	135 [120-151]	132 [121-142]	148 [110-186]	0.67
Calcium, mg/day	927 [843-1011]	929 [865-992]	812 [668-957]	0.36	1045 [934-1137]	1058 [991-1124]	1093 [927-1259]	0.93
Iron, mg/day	11 [10-12]	11 [11-12]	10 [9.0-12]	0.48	14 [13-15]	13 [12-13]	14 [12-15]	0.23
Magnesium, mg/day	395 [369-421]	404 [384-423]	365 [322-408]	0.32	469 [434-505]	440 [421-458]	492 [424-560]	0.13
Zinc, mg/day	12 [11-13]	12 [12-13]	11 [10-12]	0.38	16 [14-17]	15 [14-16]	16 [14-17]	0.57
Selenium, µg/day	54 [50-59]	53 [50-56]	43 [37-48]	**0.03** **0.009[a]#** **0.01[b]#**	68 [62-74]	64 [61-67]	75 [60-90]	0.17
Phosphorus, g/day	1.7 [1.6-1.8]	1.7 [1.7-1.8]	1.5 [1.4-1.7]	0.20	2.2 [1.9-2.2]	2.0 [1.9-2.1]	2.2 [1.9-2.4]	0.36
Iodine, mg/day	180 [161-200]	178 [164-191]	136 [113-160]	0.05	222 [200-249]	210 [196-225]	260 [186-334]	0.20
With supplements								
Vitamin A, µg/day	1381 [1243, 1520]	1390 [1285, 1495]	1251 [1072, 1429]	0.59	1423 [1258-1588]	1507 [1396-1618]	1457 [1150-1763]	0.71
Vitamin D, µg/day	8.9 (5.8, 18)[1]	10 (5.6, 19)[1]	9.4 (4.1, 15)[1]	0.23	8.0 (5.0, 13)[1]	11 (7.0, 18)[1]	9.0 (7.0, 18)[1]	0.78
Vitamin E, mg/day	20 [18-23]	21 [20-23]	19 [15-22]	0.37	22 [20-24]	24 [22-25]	22 [17-26]	0.56
Thiamin, mg/day	2.1 [1.9-2.2]	2.1 [1.9-2.2]	1.8 [1.5-2.1]	0.44	2.3 [2.0-2.5]	2.3 [2.1-2.4]	2.2 [1.9-2.5]	0.89
Riboflavin, mg/day	2.5 [2.2-2.7]	2.6 [2.4-2.8]	2.1 [1.8-2.4]	0.15	2.7 [2.5-3.0]	2.8 [2.6-3.0]	2.5 [2.2-2.9]	0.75
Niacin, mg/day	29 [27-32]	29 [27-32]	26 [22-30]	0.37	34 [30-37]	33 [31-35]	34 [19-38]	0.91
Vitamin B_6, mg/day	2.5 [2.2-2.7]	2.6 [2.4-2.8]	2.2 [1.8-2,6]	0.32	2.5 [2.2-2,8]	2.5 [2.3-2.7]	2.6 [2.2-3.0]	0.96

Folate, µg/day	389 [358-420]	404 [378-430]	345 [292-397]	0.19	395 [360-431]	391 [370-413]	407 [354-460]	0.91
Vitamin B₁₂, µg/day	7.3 [6.7-7.9]	7.2 [6.7-7.6]	5.6 [4.9-6.3]	**0.02** **0.001[a]#** **0.001[b]#**	8.7 [7.8-9.5]	8.5 [8.0-8.9]	9.3 [7.5-11]	0.57
Vitamin C, mg/day	169 [150-189]	174 [159-188]	141 [115-167]	0.23	152 [133-171)	149 [138-161)	156 [120-192)	0.94
Calcium, mg/day	927 [843-1011]	929 [865-992]	812 [668-957]	0.36	1045 [954-1137]	1058 [991-1124]	1093 [927-1259]	0.93
Iron, mg/day	11 (8.4, 15)[1]	12 (8.6, 16)[1]	11 (7.8, 15)[1]	0.50	13 (9.3, 19)[1]	13 (10, 17)[1]	16 (11, 17)[1]	0.35
Magnesium, mg/day	402 [376-429]	414 [394-434]	373 [330-417]	0.24	475 [439-511]	450 [431-469]	495 [427-562]	0.28
Zinc, mg/day	14 [13-16]	15 [14-17]	14 [11-16]	0.33	17 [16-19]	18 [17-19]	16 [14-19]	0.60
Selenium, mg/day	62 [56-67]	64 [59-69]	51 [43-60]	0.11	74 [66-82]	74 [70-79]	77 [62-93]	0.92
Phosphorus, g/day	1.7 [1.6-1.8]	1.7 [1.7-1.8]	1.5 [1.4-1.7]	0.20	2.0 [1.9-2.2]	2.0 [1.9-2.1]	2.2 [1.9-2.4]	0.36
Iodine, mg/day	203 [181-225]	209 [192-227]	161 [132-190]	0.09	239 [209-269]	241 [222-259]	268 [194-341]	0.72

#p-values obtained using independent samples t-test, all other p-values obtained using one way ANOVA. Data presented as mean [95% CI], [1] data presented as median (25, 75 percentiles),[a] p-value between CD & controls, [b] p-value between UC & controls. CD: Crohn's disease, UC: Ulcerative colitis.

Table 5. Dietary intake in women with IBD from the IBSEN III study in comparison to recommendations and the national dietary survey Norkost 3.

	IBD women (n= 390)	**NNR 2012**	**Norkost 3 (2010-2011) Women (n= 925)**
	Mean (SD)		**Mean (SD)**
Energy, MJ/day	9.5		8.0 (2.4)
Protein, E %	17 (3)	10-20 E%[a]	18 (4)
Fat, E %	36 (6)	25-40 E%	34 (7)
SFA, E %	13 (3)	<10 E%	13 (3)
MUFA, E %	14 (3)	10-20 E%	12 (3)
PUFA, E %	6 (1.8)	5-10 E%	6.2 (2.3)
Carbohydrates, E %	43 (8)	45-60 E%	44 (8)
Added sugar, E %	7.3 (5.2)	<10 E%	7.4 (5.2)
Dietary fiber, E %	2.5 (0.8)	-	2.3 (0.7)
Alcohol, E %	1.3 (2.2)	<5 E%	2.1 (4.4)
Alcohol, g	4 (7.1)	<10 g/d	6.3 (14.1)
Micronutrients[l]		**RI**	
Vitamin A, µg/day	1161 (658)	700[b]	- (-)
Vitamin D, µg/day	7.4 (4.3)	10[c]	4.9 (4.3)
Thiamine, mg/day	1.6 (0.6)	1.1	1.4 (0.5)

Riboflavin, mg/day	2 (0.9)	1.3	1.6 (0.6)
Vitamin B_6, mg/day	2 (0.8)	1.2	1.5 (0.5)
Folate, µg/day	345 (150)	300/400[d]	231 (86)
Vitamin B_{12}, µg/day	7 (3.4)	2	6 (3.7)
Vitamin C, mg/day	153 (103)	75	111 (71)
Calcium, mg/day	928 (505)	800	811 (364)
Iron, mg/day	11 (4.2)	15/9[e]	9.9 (3.5)
Zinc, mg/day	12 (4.6)	7	- (-)
Selenium, µg/day	54 (26)	50	- (-)
Iodine, mg/day	179 (111)	150	- (-)

[a]E% of 15-20 from protein is recommended for age ≥65 years, [b]given in RE= retinol equivalents, [c]20 µg vitamin D is recommended for age ≥75 years, [d]for women of reproductive age [e]post-menopausal (45-70 years). IBD: Irritable bowel disease, SD: Standard deviation, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids, RI: recommended intake, LI: lower intake level, [l] micronutrient values for IBD patients are without supplements.

Table 6. Dietary intake in men with IBD from the IBSEN III study in comparison to recommendations and the national dietary survey Norkost 3.

	IBD men (n= 328)	**NNR 2012**	**Norkost 3 (2010-2011) Men (n= 862)**
	Mean (SD)		**Mean (SD)**
Energy, MJ/day	12.0		10.9 (3.4)
Protein, E %	17 (3)	10-20 E%[a]	18 (4)
Fat, E %	36 (3)	25-40 E%	34 (7)
SFA, E %	13 (3)	<10 E%	13 (3)
MUFA, E %	13 (3)	10-20 E%	12 (3)
PUFA, E %	6.1 (1.8)	5-10 E%	6.2 (2.2)
Carbohydrates, E %	43 (7)	45-60 E%	43 (8)
Added sugar, E %	7.8 (6.3)	<10 E%	7.2 (5.7)
Dietary fiber, E %	2 (0.6)	-	2 (0.7)
Alcohol, E %	1.7 (2.1)	<5 E%	2.5 (5.2)
Alcohol, g	7 (11.7)	<20 g/d	10 (22)
Micronutrients[l]		**RI**	
Vitamin A, µg/day	1257 (720)	900[b]	- (-)
Vitamin D, µg/day	8 (4.1)	10[c]	6.7 (5.7)
Thiamine, mg/day	1.9 (0.6)	1.4	1.9 (0.7)
Riboflavin, mg/day	2.4 (0.9)	1.7	2.1 (0.8)

Vitamin B6, mg/day	2 (0.7)	1.5	1.9 (0.8)
Folate, µg/day	352 (126)	300	279 (105)
Vitamin B12, µg/day	8 (3.6)	2	8.9 (8)
Vitamin C, mg/day	133 (79)	75	105 (77)
Calcium, mg/day	1054 (499)	800	1038 (514)
Iron, mg/day	13 (4.4)	9	13 (4)
Zinc, mg/day	15 (5)	9	- (-)
Selenium, µg/day	65 (26)	60	- (-)
Iodine, mg/day	214 (119)	150	- (-)

[a]E% of 15-20 from protein is recommended for age ≥65 years, [b]given in RE= retinol equivalents, [c]20 µg vitamin D is recommended for age ≥75 years. IBD: Irritable bowel disease, SD: Standard deviation, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids, RI= recommended intake, LI: lower intake level. [1] Micronutrient values for IBD patients are without supplements.

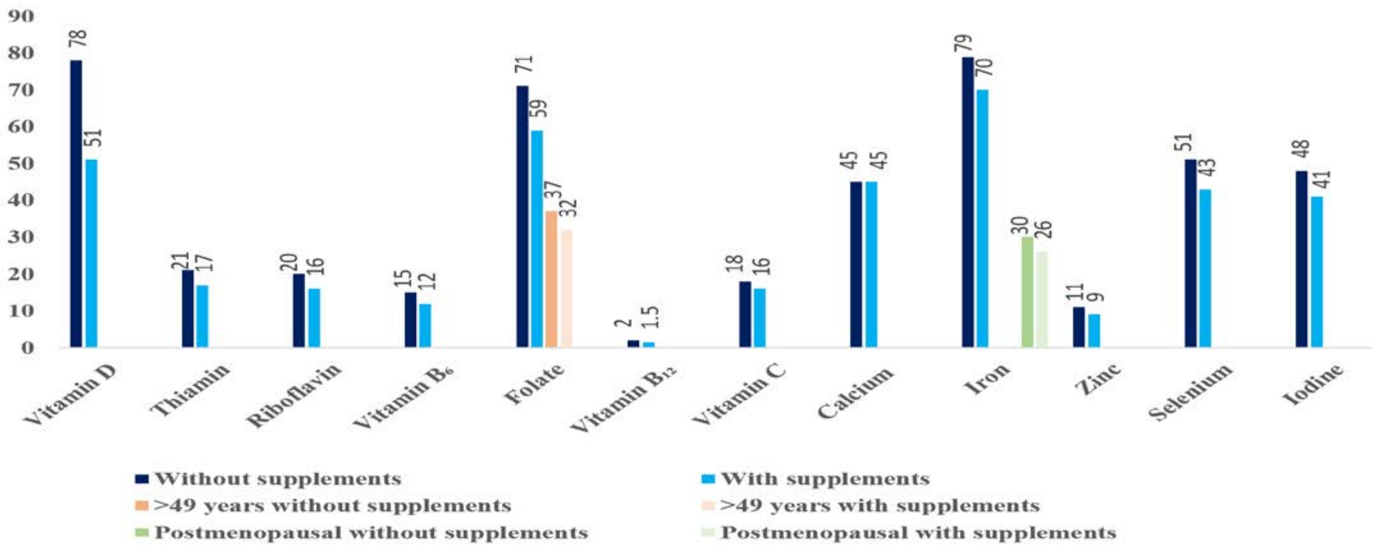

Figure 2. Percentage of women with IBD with micronutrient intake <RI in NNR 2012. Women>49 years, n=104 of 390, postmenopausal women: >45 years. RI: recommended intake., folate in women of reproductive age (<49 years) and those over (113), and iron in pre- and postmenopausal (>45 years) women (114).

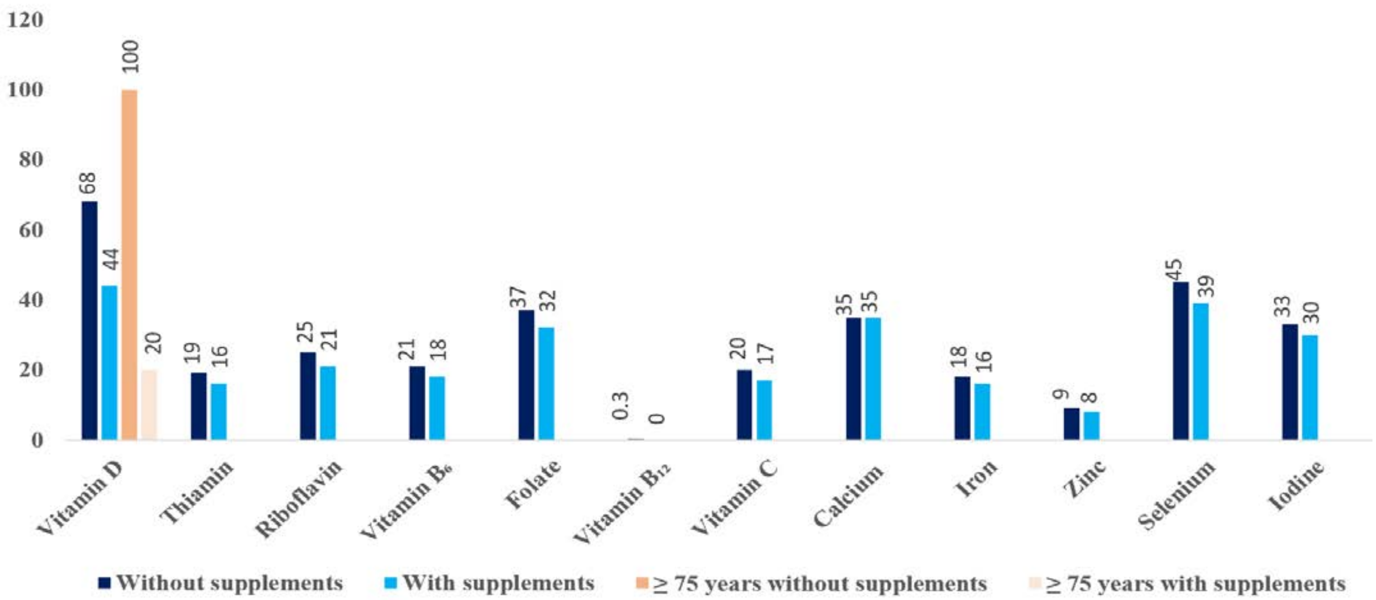

Figure 3. Percentage of men with IBD with a macronutrient intake <RI in NNR 2012. RI: recommended intake. Vitamin D was presented for those under and ≥75 years (n=5).

Table 7. Intake of different food groups in gram/day in CD, UC and non-IBD controls.

	Women				Men			
	CD (n=140)	UC (n=250)	Controls (n=42)	p-value	CD (n= 91)	UC (n=237)	Controls (n=19)	p-value
Bread, g/day	142 [127-157][1]	138 [126-149][1]	148 [116-180][1]	0.76	211 [185-237][1]	201 [187-215][1]	197 [150-245][1]	0.75
White bread, g/day	18 (9, 30)	20 (10, 34)	17 (10, 27)	0.69	36 (20, 102)	32 (19, 53)	34 (12, 37)	0.43
Bread <50% whole grain, g/day)	9.0 (0.5, 64)	9.0 (0.5, 64)	9.0 (0.5, 64)	0.73	9.0 (0.5, 64)	21 (0.5, 64)	9.0 (0.5, 64)	0.20
Bread >50% whole grain, g/day	30 (1.0, 128)	22 (1.0, 73)	9.0 (0.5, 87)	0.40	64 (9.0, 213)	64 (1.0, 149)	128 (22, 213)	0.17

Crisp bread, g/day	6.0 (0.2, 19)	6.0 (0.2, 20)	4.8 (0.2, 45)	0.18	2.8 (0.1, 9.0)	3.0 (0.1, 7.0)	3.1 (0.1, 22)	0.39
Other Grain products, g/day	92 (57, 158)	105 (60, 168)	120 (66, 170)	0.49	95 (53, 191)	110 (59, 180)	145 (63, 226)	0.43
Vegetables, g/day	386 [338-433][1]	386 [350-421][1]	334 [260-409][1]	0.53	314 [271-357][1]	289 [266-312][1]	389 [301-477][1]	0.06
Fruits & berries, g/day	197 (106, 355)	235 (128, 382)	175 (74, 329)	0.19	212 (97, 413)	204 (106, 373)	202 (115, 391)	0.39
Meat & offal, g/day	138 [126, 151][1]	133 [123, 143][1]	130 [110, 150][1]	0.76	199 [177, 221][1]	190 [179, 202][1]	187 [162, 212][1]	0.75
Fish & shellfish, g/day	59 (37, 100)	59 (33, 98)	40 (23, 72)	**0.03** **0.007[a]#** **0.009[b]#**	76 (37, 115)	68 (39, 113)	108 (38, 149)	0.76
Milk, cream & ice cream g/day	203 (73, 397)	187 (75, 369)	197 (77, 421)	0.83	223 (92, 495)	281 (86, 440)	309 (143, 436)	0.91
Cheese, g/day	24 (14, 39)	26 (14, 45)	17 (8.9, 30)	0.19	30 (15, 49)	31 (16, 50)	25 (15, 47)	0.65
Sugar & sweets, g/day	16 (5.0, 34)	19 (10, 43)	22 (9.6, 41)	0.14	20 (8.0, 46)	21 (8.0, 38)	19 (8.3, 41)	0.76

#p-values obtained using Mann-Whitney U test, all other p-values obtained using one way ANOVA. Data presented as median (25, 75 percentiles), [1]data presented as mean [95% CI], [a]p-value between CD & controls, [b] p-value between UC & controls. CD: Crohn's Disease, UC: Ulcerative colitis.

4.4 FODMAP intake

4.4.1 FODMAP intake in the study sample

There was no significant difference in the FODMAP intake in CD, UC and non-IBD controls (**Table 8**).

Total FODMAP intake did not change with smoking status, gender or Swedish snus use. However, for FODMAP subgroups, several differences were detected. GOS intake was significantly higher in non-smoking participants (p=0.04). Both lactose and fructan intake were significantly lower in Swedish snus users (p=0.04 and 0.01, respectively).

Women who used pre-, and probiotics had significantly higher consumption of excess fructose and total FODMAP (p=0.001 and p=0.01, respectively) (**Table 9)**. We did not observe any differences in men.

4.4.2 FODMAP intake and dietary changes

A total of 100 (13%) out of 779 participants followed the gluten-, lactose free and a low FODMAP diet since symptom debut. This resulted in significantly lower intakes of total FODMAP and lactose (p<0.001), fructan and excess fructose (p=0.04), and polyols (p=0.008) in those who changed their diet compared to those who did not. Only 36 participants followed the low FODMAP diet only.

4.4.3 Dietary sources to FODMAP in IBD patients

There were no significant differences in FODMAP intake from different food groups between the study groups (**Table 10**). As illustrated in **Figure 4**, a combination of milk & dairy, fruits, sugar & sweets, vegetables, bread and other grain products together made up approximately 89% of total FODMAP intake in the present study.

The topmost single food items responsible for highest fructan, GOS, excess fructose, lactose and polyol consumption in IBD patients, are presented in **Figure 5**. Onion, bread and pulses were of highest rank as sources of fructan and GOS, respectively. Apple juice and apples were the main sources to excess fructose. Unexpectedly, we found that chocolate was the fourth source to lactose (1.42 gram/day), after milk and yoghurt. Candy and sweets contributed the most to polyol intake with a daily amount equal to 2.4 gram. The detailed tables with the top ten sources to every FODMAP subgroup are given in Appendix 9.

Table 8. Median intake of FODMAP subgroups and total FODMAP in gram/day in CD, UC and non-IBD controls.

	Women				Men			
	CD (n=140)	**UC (n=250)**	**Controls (n=42)**	**p-value**	**CD (n=91)**	**UC (n=237)**	**Controls (n=19)**	**p-value**
Fructans, g/day #	3.6 [3.3-3.9][1]	3.5 [3.3-3.7][1]	3.5 [2.8-4.3][1]	0.89	4.3 [3.9-4.8][1]	4.0 [3.8-4.3][1]	3.8 [3.2-4.3][1]	0.31
GOS, g/day	0.5 (0.3, 1.4)	0.5 (0.3, 0.9)	0.4 (0.2, 0.9)	0.43	0.6 (0.4, 1.4)	0.6 (0.3, 1.0)	0.9 (0.4, 1.4)	0.05
Excess fructose, g/day	2.7 (1.2, 4.8)	3.1 (1.6, 5.0)	2.2 (1.2, 5.4)	0.86	2.7 (1.6, 2.7)	2.5 (1.3, 4.8)	3.1 (1.7, 4.4)	0.28
Lactose, g/day	14 (6.6, 25)	13 (7.0, 22)	13 (6.3, 23)	0.84	18 (10, 29)	17 (7.9, 26)	21 (9.0, 28)	0.89
Polyols, g/day	3.0 (1.2, 5.3)	3.6 (1.9, 6.4)	2.6 (1.4, 7.1)	0.23	2.9 (1.6, 7.1)	2.8 (1.3, 5.5)	2.9 (1.4, 6.3)	0.56
Total FODMAPs, g/day #	31 [27-34][1]	31 [28-33][1]	28 [22-34][1]	0.77	35 [31-38][1]	33 [31-36][1]	34 [27-42][1]	0.81

P-values obtained using one way ANOVA. Data presented as median (25, 75 percentiles), [1]data presented as mean [95% CI]. CD: Crohn's disease, UC: Ulcerative colitis, GOS: galactooligosaccharides, FODMAP: fermentable oligo-, di-, monosaccharides & polyols, excess fructose= fructose-glucose, MJ: Mega joule.

Table 9. FODMAP intake in g/day in men and women split according to use or no use of pre-, and probiotics.

	Women Use of pre-, probiotics			Men Use of pre-, probiotics		
	Yes (n=87)	**No (n=335)**	**p-value**	**Yes (n=56)**	**No (n=276)**	**p-value**
Fructans, g/day #	3.7 [3.3-4.1][1]	3.5 [3.3-3.7][1]	0.42	4.2 [3.7-4.7][1]	4.0 [3.8-4.3][1]	0.60
GOS, g/day	0.5 (0.3, 0.9)	0.5 (0.3, 0.9)	0.14	0.7 (0.4, 1.3)	0.6 (0.3, 1.0)	0.09
Excess fructose, g/day	4.0 (1.9, 5.8)	2.6 (1.3, 4.6)	**0.001**	2.7 (1.6, 2.7)	2.5 (1.3, 4.8)	0.15
Lactose, g/day	16 (8.7, 26)	13 (6.8, 22)	0.08	20 (11, 27)	17 (8.5, 27)	0.22
Polyols, g/day	3.2 (1.8, 5.5)	3.5 (1.8, 6.4)	0.83	2.6 (1.5, 7.4)	2.8 (1.4, 6.0)	0.69
Total FODMAPs, g/day #	37 [30-43][1]	29 [27-31][1]	**0.01**	36 [32-41][1]	33 [31-36][1]	0.28

#tested using independent sample t-test. Other p-values obtained using Mann-Whitney U test. GOS: Galactooligosaccharides, FODMAP: fermentable oligo-, di-, monosaccharides & polyols, excess fructose= fructose-glucose.

Table 10. Contribution to total FODMAP intake in gram/day from different food groups in CD, UC and non-IBD controls.

	Women				Men			
FODMAP from	**CD (n=140)**	**UC (n=250)**	**Controls (n=42)**	**p-value**	**CD (n= 91)**	**UC (n=237)**	**Controls (n=19)**	**p-value**
Milk, cream & ice cream, g/day	9.2 (3.3, 19)	8.9 (3.2, 18)	8.6 (3.1, 19)	0.81	9.6 (3.2, 18)	8.0 (3.0, 16)	11 (6.2, 19)	0.91
Sugar & sweets, g/day	2.7 (0.7, 6.7)	2.2 (0.7, 6.0)	3.4 (1.0, 7.0)	0.18	2.7 (0.7, 6.7)	3.5 (1.1, 7.0)	2.8 (1.1, 6.9)	0.74
Fruits & berries, g/day	3.0 (1.2, 6.0)	2.9 (1.1, 5.3)	2.8 (0.8, 5.8)	0.77	2.8 (1.3, 5.6)	3.4 (1.5, 5.8)	2.7 (1.4, 5.1)	0.26
Vegetables, g/day	2.0 (1.1, 3.3)	2.0 (1.3, 3.5)	1.9 (0.7, 3.2)	0.73	1.8 (1.0, 3.0)	2.0 (1.2, 3.4)	2.3 (1.1, 3.8)	0.20
Bread, g/day	2.0 [1.9, 2.2][1]	1.7 [1.5, 2.0][1]	1.8 [1.3, 2.2][1]	0.65	2.0 [1.9, 2.2][1]	1.6 [1.5, 1.8][1]	2.3 [1.8, 2.9][1]	0.85
Grain products, g/day	0.7 (0.3, 1.7)	0.7 (0.3, 1.7)	0.8 (0.4, 1.9)	0.61	0.8 (0.3, 1.7)	0.9 (0.4, 1.9)	1.5 (0.4, 2.5)	0.33
Cheese, g/day	0.1 (0, 1.3)	0.1 (0, 0.6)	0.1 (0, 1.4)	0.39	0.07 (0, 1.3)	0.1 (0, 1)	0.1 (0, 3.2)	0.93
Beverages, g/day	0.07 (0, 0.2)	0.1 (0, 0.3)	0.02 (0, 0.2)	0.57	0.07 (0, 0.2)	0.1 (0, 0.4)	0.2 (0, 3.8)	0.33

p-values obtained using one way ANOVA. Data presented as median (25, 75 percentiles), [1]data presented as mean [95% CI]. CD: Crohn's disease, UC: Ulcerative colitis, FODMAP: fermentable oligo-, di-, monosaccharides & polyols.

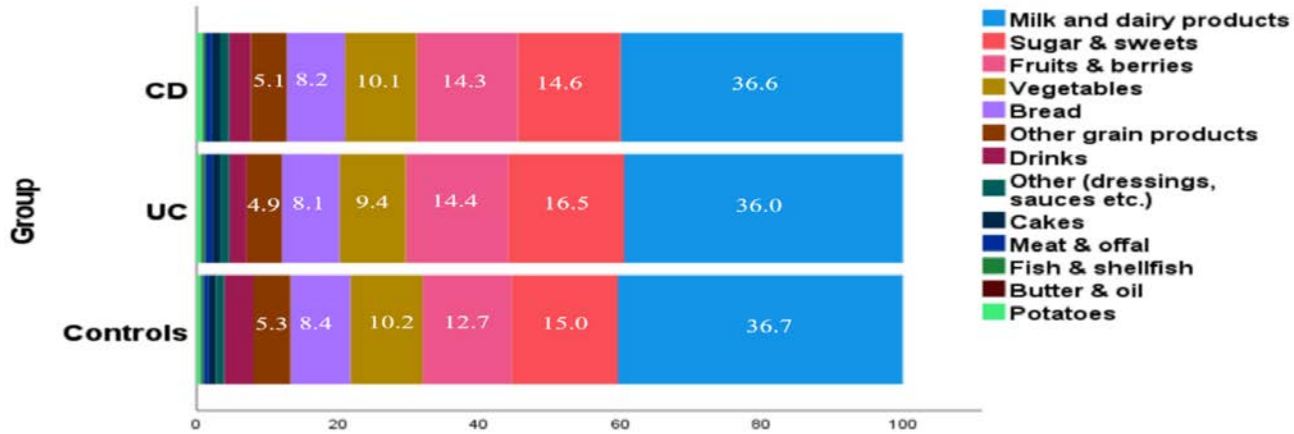

Figure 4. Mean percentage of FODMAP intake from different food groups for CD, UC and controls.
Percentages from the other food groups are not presented and range from 0.1% (butter & oil) to 3.6% (cheese). CD: Crohn's disease, UC: Ulcerative colitis.

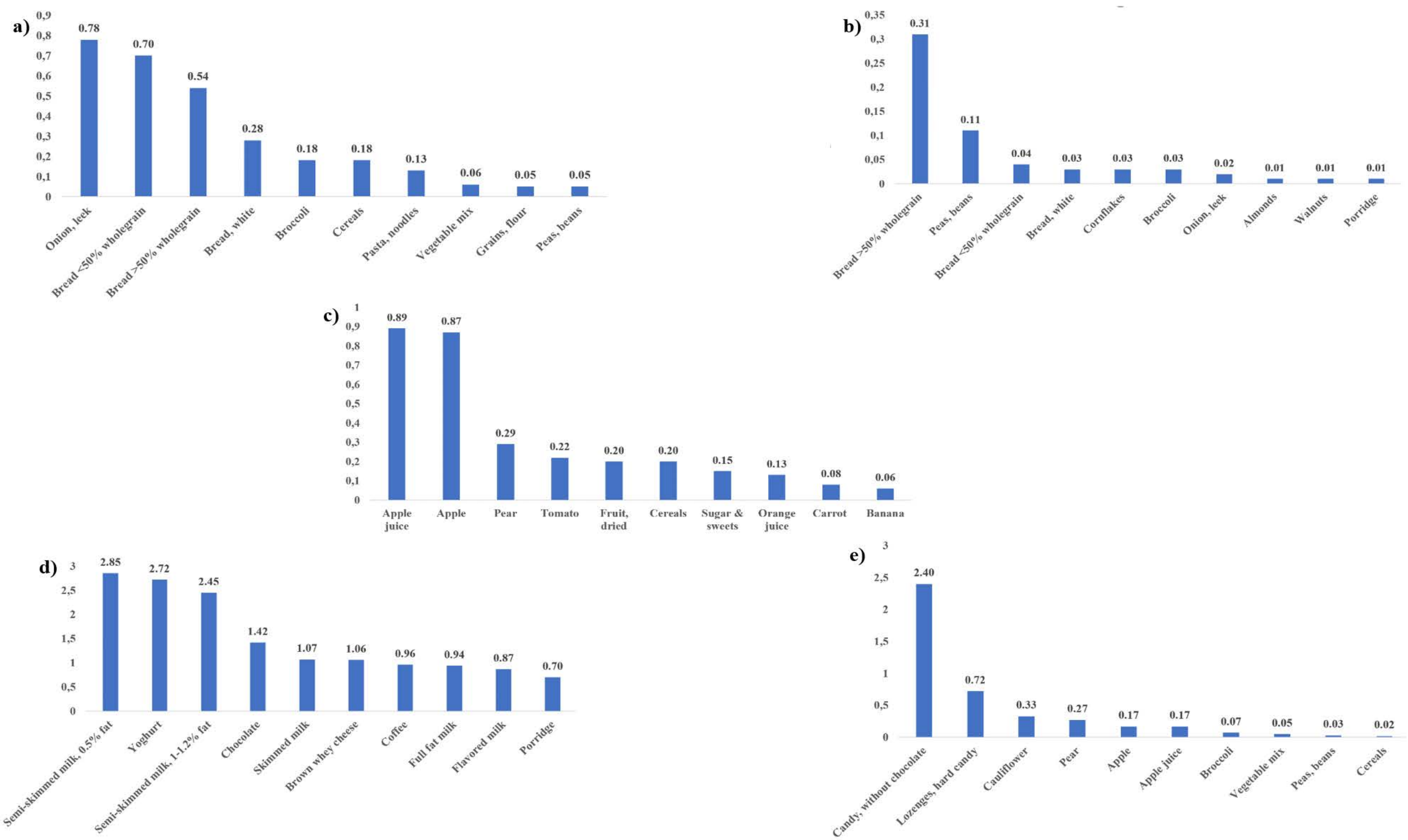

Figure 5. Top ten dietary sources FODMAP subgroups as g/day in the diet of IBD patients, a) sources to fructan, b) sources to GOS, c) sources to excess fructose (fructose-glucose), d) sources to lactose & e) sources to polyols.

4.4.4 Dietary modification and use of pre-, and probiotics

A total of 96 IBD patients changed their diet before diagnosis, but this number was reduced to 88 after diagnosis. These changes involved vegetarian diet, gluten free, lactose free/reduced, high fat/low carbohydrate, low FODMAP and other. We did not find any statistical significant difference between the disease groups and non-IBD controls, regarding dietary changes before and after diagnosis (**Table 14**). More women than men tended to change their diets previous to as well as after diagnosis. Before diagnosis, 18% of women with IBD adopted a dietary change compared to only 7% in men. After diagnosis, the percentage of women reported to change their diet dropped to (14%), but was still higher in comparison to men (10%). Regular use of pre- and probiotics was adopted by 143 (19%) participants, with no significant difference between the groups. Of these, 130 (91%) were IBD patients with 40% men and 60% women.

Table 14. Dietary modifications and regular use of pre-, and probiotics in CD, UC and control group.

	Women				**Men**			
	CD (n=140)	**UC (n=250)**	**Controls (n=42)**	**p-value**	**CD (n=91)**	**UC (n=237)**	**Controls (n=19)**	**p-value**
Specific diet before diagnosis (n=689) (%)	27 (19)	45 (18)	7 (17)	0.91	7 (8)	17 (7)	2 (10)	0.89
Specific diet after diagnosis (n=692) (%)	23 (16)	33 (13)	10 (24)	0.19	11 (12)	21 (9)	1 (5)	0.49
Regular use of pre/probiotics (n=694) (%)	29 (21)	49 (20)	9 (21)	0.96	13 (14)	39 (16)	4 (21)	0.80

P-values obtained using Chi-squared test. CD: Crohn's disease, UC: Ulcerative colitis.

4.4.5 FODMAP intake and IBS diagnosis in IBD patients

Table 11 presents the intakes of FODMAP in the study population groups. FODMAP intake did not differ in relation to IBS diagnosis in neither CD nor UC patients.

Results from the logistic regression analysis of FODMAP intake versus IBS diagnosis are presented in **Table 12**. We did not find any association between FODMAP intake and IBS diagnosis in IBD patients, both in unadjusted and adjusted models. The unadjusted model for lactose was close to significance (p=0.06).

Table 13 shows logistic regression analysis results after splitting the sample according to dietary changes after symptom onset versus no dietary changes. The analysis showed no associations in patients who did not change their diet after symptom debut. However, in patients who did change their diet, there was a positive association between the IBS diagnosis and fructan intake (OR 1.9, 95% CI 1.2, 3.1, p=0.009). There were more patients with IBS in the diet changing group (66%) versus patients who did not adopt changes (43%).

Another logistic regression analysis was performed for the association between dietary changes after symptom debut and different stool consistencies. There were statistically significant more diarrhea (p<0.001), constipation (p=0.009) and mixed stool (p<0.001) in the group that followed a gluten-, lactose free and low FODMAP diet compared to the group with no dietary changes.

Table 11. Median FODMAP intake in gram/day in CD, UC and controls according to IBS diagnosis.

	CD (n=199)			**UC (n=445)**		
	IBS (n=93)	**No IBS (n=106)**	**p-value**	**IBS (n=200)**	**No IBS (n=245)**	**p-value**
Fructans, g/day	3.7 [3.3-4.0][1]	4.0 (3.5-4.3)[1]	0.53#	3.7 [3.5-4.0][1]	3.9 [3.6-4.0][1]	0.52#
GOS, g/day	0.5 (0.3, 0.9)	0.6 (0.3, 1.0)	0.16	0.5 (0.3, 1.0)	0.5 (0.3, 1.0)	0.32
Excess fructose, g/day	2.6 (1.0, 5.0)	2.5 (1.0, 5.0)	0.36	3.0 (2.0, 4.0)	3.0 (1.0, 5.0)	0.94
Lactose, g/day	13 (6.0, 25)	17 (9.0, 27)	0.07	15 (8.0, 25)	15 (8.0, 25)	0.82
Polyols, g/day	3.0 (1.0, 7.0)	3.0 (1.0, 5.0)	0.93	3.0 (2.0, 6.0)	4.0 (2.0, 6.0)	0.27
Total FODMAPs, g/day	31 [27-35][1]	33 [29-36][1]	0.56#	31 [28-33][1]	33 [31-36][1]	0.22#

#p-values obtained using independent sample t-test. All other p-values obtained using Mann- Whitney U test. Data presented as median (25, 75 percentiles), [1]data presented as mean (95% CI). CD: Crohn's disease, UC: Ulcerative colitis, IBS: irritable bowel syndrome, GOS: galactooligosaccharides, FODMAP: fermentable oligo-, di-, monosaccharides & polyols, excess fructose= fructose-glucose.

Table 12. Logistic regression analysis of FODMAP intake and IBS diagnosis in IBD patients.

		IBS		
		OR	**95% CI**	**p-value**
Fructan	Unadjusted	0.98	0.90, 1.05	0.54
	Adjusted[a]	1.01	0.93, 1.09	0.84
GOS	Unadjusted	0.83	0.62, 1.09	0.18
	Adjusted[a]	0.91	0.68, 1.22	0.53
Excess fructose	Unadjusted	0.99	0.95, 1.03	0.61
	Adjusted[a]	0.99	0.95, 1.04	0.89
Lactose	Unadjusted	0.99	0.98, 1.00	0.06
	Adjusted[a]	0.99	0.98, 1.00	0.17
Polyols	Unadjusted	1.02	0.99, 1.05	0.21
	Adjusted[a]	1.03	0.95, 1.06	0.13
Total FODMAP	Unadjusted	0.99	0.99, 1.00	0.12
	Adjusted[a]	0.99	0.99, 1.00	0.60

[a]Adjusted for age, sex, smoking status, use of pre- & probiotics, dietary changes after symptom debut and diagnosis (UC and CD). FODMAP: fermentable oligo-, di, monosaccharides & polyols, GOS: galactooligosaccharides, excess fructose= fructose-glucose, OR: odds ratio, 95% CI: 95% confidence interval.

Table 13. Logistic regression analysis of FODMAP intake and IBS diagnosis, stratified by dietary changes.

		Made no dietary changes after symptom onset (n=640)			Made dietary changes after symptom onset[a] (n=59)		
		OR	95% CI	p-value	OR	95% CI	p-value
Fructan	Unadjusted	0.95	0.87, 1.00	0.22	1.30	0.98, 1.80	0.06
	Adjusted[b]	0.97	0.89, 1.00	0.50	1.90	1.20, 3.10	**0.009**
GOS	Unadjusted	0.78	0.58, 1.00	0.13	0.95	0.43, 2.10	0.91
	Adjusted[b]	0.87	0.64, 1.20	0.39	1.90	0.50, 7.00	0.35
Excess fructose	Unadjusted	0.99	0.95, 1.00	0.69	1.00	0.86, 1.20	0.98
	Adjusted[b]	0.99	0.95, 1.01	0.88	0.97	0.76, 1.20	0.84
Lactose	Unadjusted	0.99	0.98, 1.00	0.12	1.00	0.95, 1.00	0.92
	Adjusted[b]	0.99	0.98, 1.02	0.12	1.00	0.96, 1.10	0.59
Polyols	Unadjusted	1.00	0.99, 1.00	0.15	0.99	0.90, 1.10	0.99
	Adjusted[b]	1.00	0.99, 1.10	0.13	0.98	0.87, 1.10	0.70
Total FODMAP	Unadjusted	0.99	0.98, 1.03	0.23	1.00	0.97, 1.00	0.71
	Adjusted[b]	0.99	0.98, 1.00	0.26	1.01	0.97, 1.10	0.48

[a]Dietary changes include gluten-, lactose free and low FODMAP diet. [b]Adjusted for age, sex, smoking status, use of pre- & probiotics and diagnosis (UC and CD). FODMAP: fermentable oligo-, di-, monosaccharides & polyols, GOS: galactooligosaccharides, excess fructose= fructose-glucose, OR: odds ratio, 95% CI: 95% confidence interval.

5 Discussion

5.1 Methodological considerations

Researchers need to address method related problems to minimalize their negative implications on the results and validity of the measurements. Measurement errors are of two types, random and systematic. Random errors affect the preciseness of the measurement, whereas systematic errors interfere with the validity and lead to bias (51, 115). A measurement precision is divided in reliability (same results obtained with repeated measurements under identical conditions) and reproducibility (variation in measurement when changing one of the conditions) (115).

Validity includes internal and external validity (51, 115). Internal validity assesses if a method really measures what it was intended to measure. It might be strongly influenced by selection bias, information bias and statistical validity (115). The external validity is related to the degree to which results from the study sample can be generalized to the population represented by the sample or to other populations. When individuals in the sample deviate from other individuals from the same population, the selection bias occurs. Information bias is when incorrect information is registered as a consequence to mistaken reporting by the individuals, either intentionally or non-intentionally. The third type of bias, the statistical bias depends on correct use of statistical tests, effect estimates and adjustments for confounding.

The confounders are variables that may affect both the causing factor and the effect variable (115).

5.1.1 Internal validity

Information bias

Dietary FFQ

In general, there are some factors that might interfere with and thereby influence the validity of dietary data obtained from FFQs (51). Using an FFQ limits the number of foods to be assessed, thereby not being able to catch dietary variations and may lead to misreporting (51). A validation study of the FFQ was carried out by Carlsen et al using measured energy expenditure (by Actireg®) and a seven-days weighed record (66). Results showed that the FFQ underestimated mean energy intakes by 11% compared to mean energy expenditure. Energy estimates were however similar to those obtained by the weighed record. E% from fat and added sugar were significantly underestimated by the FFQ, whereas E% from total carbohydrates and protein were overestimated compared to weighed record. Moreover, intakes of some foods such as berries, vegetables, tea and coffee were significantly higher estimated by the FFQ than by the weighed record.

There were no difference between methods regarding intakes of chocolate, fruits (also juices), nuts and wine (66). We have to take into consideration the possible coexistence of over- and underreporting with the use of different dietary assessment tools, when comparing the results from the present study with Norkost 3. They used the 24 hour dietary recall, which is a completely different method from FFQ (51, 111).

Underreporting of dietary intakes may influence the results to an extent depending on the foods and nutrients affected and the proportion of under-reporters (116). Some studies used the Goldberg method to identify under-reporting (116). Carlsen et al suggested to exclude the 5% highest over- and under-reporters, when measuring dietary intakes using FFQ (66). We did not use any of these methods, since our population consist mainly of recently diagnosed IBD patients. Lower dietary intakes in this patient group might reflect real intakes rather than under-reporting, and can be related to their symptoms, disease activity and its influence on appetite (13, 16). Instead, we used dietary assessment publications from other IBD populations when deciding cut-offs (67-69).

Another limitation to the use of FFQs is the requirement of a minimum level of literacy amongst participants in order to answer the questions (51), especially in self-administered FFQ, as used in the IBSEN III study. The digitalized format of the FFQ exposed it to some random errors, as some participants might have clicked on wrong answers. At the same time, we minimized the risk of missing data associated with manual handling of paper-based FFQs.

Since FFQ is a retrospective method, reporting previously consumed food involves high risk of wrongly reported frequencies and imprecise portions due to memory issues (51). Patients who were diagnosed prior to inclusion (> 50% of CD and UC) might have been affected by their disease or symptoms when responding to different questionnaires. This phenomenon is referred to as recall bias, the impact of a disease on participants answers to standardized questions (115). Also participants diagnosed at time of inclusion were exposed to recall bias, since the FFQ measured dietary intake for the preceding year. Furthermore, both CD and UC patients are concerned about diet and its relationship to IBD, and might have been extra attentive as they filled the FFQ (14, 16). However, we do not assume that recall bias has resulted in big differentiations between the groups, as non-IBD controls also might link their symptoms to diet (117).

Self -reported questionnaires

The questions used to collect information about demographic variables, as well as use of pre- and probiotics and dietary changes were not validated in advance. The quality of the measurements plays a crucial role in determination of associations between explaining factors and the outcome (115). The quality of the data depends on how well the questions are formulated and how well the answer options captures the real variation. A variable can be measured through different combinations of questions and answers, leading to multiple meaning and interpretations. One question used in the IBSEN III was about the regular use of pre- and probiotics (Appendix 5). This question could be answered wrongly depending on how the word *regularly* was understood. It could be thought of as using these products every day, for 5 days a week or even more or less. Using more specific answer alternatives, by defining the frequency of use in days per week could have reduced any misinterpretations that possibly affect the number of respondents to a question. The questions used in the present study should be validated for future use in the same study population. A questionnaire developed for a specific population is not necessarily valid in other populations (115).

FODMAP compilation

In the present study, we aimed to contribute to the FODMAP research field in Norway. Since there are neither FODMAP data available in the Norwegian food composition database, nor analytical publications of FODMAP content in Norwegian food available, we tried to use data from Monash University. However, the FODMAP data from Monash University was not sufficiently detailed to be used in our estimations. For this reason, we compiled detailed food composition data and based our calculations on previous publications that analyzed FODMAP content in different foods and beverages. We compiled quantities as grams of FODMAPs/100 gram of fresh weight of food, whenever available.

Since FODMAP intake was calculated based on the dietary FFQ, the results are affected by the same type of errors, as described for intakes of food and nutrients (see information bias). In addition, there are some limitations related to our FODMAP compilation work. First, some of the food items used in the dietary FFQ as well as values for FODMAP subgroups were not found during the literature searches. This have resulted in food items with missing values. For example, we could not find measurement of fructan content in chocolate or the GOS content in nuts.

Secondly, it was difficult to identify the amounts of different ingredients in composite food products such as yoghurt with muesli and juices with multiple fruits. This might have contributed to imprecise estimates of FODMAP amounts in food. The yoghurt types Rislunsj, Go'Morgen and YT, were not given a fructan value, due to lack of information about ingredients. Some of these products may include added fructan. One previous publication has reported both fructan and GOS content in muesli (28).

Third, the FODMAP values will also differ because we used publications from different countries. FODMAP content in food, (mostly oligosaccharides) can be altered due to many factors such as maturity grade, variations in seasons, climates, analytical procedures, and the temperature and technique used during food storage (87). Furthermore, use of different analytical and extraction methods across the studies also have an impact on FODMAP identification in foods (28, 32). For example, the use of high performance liquid chromatography (HPLC) in fructan quantification detects only the short chain fructans and not those with longer chains (28). To minimize the impact of this variation on our data, we used the mean value from all available publications on one food or food group. The process involving collection of FODMAP values from publications, as well as the mean calculations were performed manually before the KBS import step. We cannot exclude random errors related to typing, copying and clicking.

Fourth, FODMAP content in grains, cereals and bread was estimated using values from dry weight, even though some publications reported fresh weight contents (28, 90). Dry weights for flours and grains were used because the FODMAP values in bread and other grain products varies according to the grains used in the final product (rice- lower FODMAP, durum wheat- higher FODMAP) (28). In Norway, the bread is different from other countries, for example Australia. Therefore, we did not use bread values from Australia, as it would have influenced our data (28).

There are some noticeable advantages to our FODMAP compilation work. The results including the food and beverages found in the FFQ from the IBSEN III study were imported to the food database AE-18 in KBS. FODMAPs were added as food constituents in line with other nutrients. This gave us the possibility to assess FODMAP intake in gram/day for the first time in a Norwegian IBD population.
According to the limitations previously discussed, we suggest that the most accurate and country specific FODMAP content of foods and beverages are those obtained from direct analysis of local food samples. However, when this is not found, compilation of food composition FODMAP data from similar products are the second best preferred method, as suggested by Greenfield and Southgate (62).

Non-IBD participants as the control group

The control group in the present study consist of non-IBD patients, with the same symptoms as IBD patients, but with no IBD diagnosis. Dietary assessment studies involving patients with IBS reported that they also adopt restrictive diets and exclude foods that exacerbate symptoms (39). Consequently, the diet of IBS patients is expected to be of poorer quality compared to the general population (39). From our results, we found that 10% and 8% of non-IBD controls reported no fish and meat intakes, respectively. This was even higher than in IBD patients (4% for fish and 6% for meat, respectively). We could possibly have missed some significant differences in dietary and FODMAP intakes as we used non-IBD participants as the control group.

Confounding

We observed statistically significant differences in intake of energy, some macro- and micronutrients in addition to FODMAPs. Consequently, we applied the analyses for men and women separately to minimize the confounding of gender on dietary intakes. In the analysis of FODMAP intake and its association to IBS diagnosis in IBD patients, we adjusted the logistic regression models according to variables which affected FODMAP intake. These included gender, smoking status, Swedish snus use, pre- and probiotics, and diagnosis (CD & UC). The logistic regression analysis of dietary changes and its association to stool types was not adjusted. We included participants who used pre- and probiotics in the FODMAP intake assessment, as we did not define it as an exclusion criteria. A possibility of other confounding factors affecting our results cannot be fully excluded.

Multiple statistic testing

Performance of many statistical testes, as in this master thesis often increase the rate of false positives. When performing a t-test once, there will be a chance of type I error equal to 5%, given that the null hypothesis is true (118). The rate of type I error increases according to the number of comparisons or tests performed. One method used in order to correct for this type of error is called the Bonferroni corrections. However, this method is considered to be too conservative (118). In this master thesis, we used one way ANOVA analysis to test for differences between CD, UC and non-IBD controls. Due to the multiple testing problem (especially for macro- and micronutrient intakes), more of the p-values<0.05 might be false positives. However, this is an explorative study that may generate new hypotheses about IBD patients from the IBSEN III study.

5.1.2 External validity

Selection bias

Only 41% of participants responded to the dietary FFQ, where over half of them were women. Highly educated, non- smoking women between 19 and 48 years had the highest response rates. Regarding what has been previously reported about dietary interest and beliefs in IBD patients, the FFQ response rate is considered low (14, 16, 18). In a study from Italy, authors found that among IBD patients who received dietary guidance for their disease, more than two thirds of them requested even more advice (18). In Norway, it has been shown that education is inversely correlated with tobacco use and sugar intake, but is proportional to intake of fruits and vegetables (119, 120). Both men and women with higher education seem to have better health and live longer. This gives rise to systematical variances referred to as health related social differences (121). It is known that people who are concerned about health related issues are more likely to participate in epidemiological studies (115). More women with IBD compared to men reported to be interested in diet, or thought of it as a valuable factor in their disease therapy (14). All these factors probably explain more frequent participation in the IBSEN III study, and elevated response rates to the dietary FFQ among women with higher education.

Participants in the IBSEN III study had to answer many questionnaires, and most of them were web-based (52). This requires a minimum of technological skills among participants. Older participants may not be as updated in internet and software use as younger adults, thus affecting their participation rate. Since multiple hospitals were involved in the recruitment process, patients from one or more region or hospital may be over represented. Some of the hospitals might have used reminders in the form of text messages, letters or even sent new questionnaires to participants. Such methods are often adopted in research to ensure response to questionnaires and increase participation rates (115). Another factor affecting the selection may be related to the inclusion of non-IBD controls. It was limited to the centers where biological samples could be collected (Oslo University Hospital, Akershus University Hospital and Vestfold Hospital). Again, the population from Oslo, Akershus and Vestfold could have been overrepresented compared to Hedmark, Østfold, Telemark, Aust- and Vest Agder, where no controls were included (52). Furthermore, this could have contributed to the small sized control group.

Some selection bias is likely in the present study due to low response rates to the dietary FFQ, higher participation rates among women, especially in CD and the limited inclusion of non-IBD controls. We also noticed a higher proportion of participants with higher educational level compared to the general Norwegian population (122). Despite the selection bias, this master thesis provides results from the largest sample with available dietary data, collected from the adult IBD population in Norway. This includes both men and women from South Eastern health district, the biggest hospital trust in Norway, which makes up approximately half the Norwegian population (123).

5.1.3 Strengths

There were several strengths to this study. First a large cohort of Norwegian IBD patients of both genders was included. Second, the inclusion of a control group for comparison. Third, FODMAP values for a number of Norwegian foods were collected and compiled. Moreover, the FODMAP intake was assessed for the first time in gram/day in Norwegian IBD patients and in controls.

5.2 Dietary intake in IBD patients

This master thesis provides a detailed description of habitual dietary intake of energy and nutrients in a large cohort of Norwegian IBD patients. Dietary assessment was performed for a total sample of 718 IBD patients (231 with CD and 487 with UC).

Modification of diet including the gluten-, lactose free and the low FODMAP diet were adopted by 14% of the study sample. Previous publications reported much higher percentages (50-70%) of IBD patients who restricted, modified the diet or omitted one or more foods (14, 16, 18, 19). We did not ask about restricting or excluding specific food items or groups, which might explain lower rates seen in our sample compared with other studies. Another explanation might be related to differences in disease duration, as IBD patients in the present study were newly diagnosed. In contrast, IBD populations from the other studies have had the disease for longer periods, ranging from 5 to 21 years (14, 16, 18, 19).

5.2.1 Intake of energy and macronutrients

The intake of energy and macronutrients both in E% and in gram in IBD patients were quiet similar to that in non-IBD controls. E% from protein was higher in women from our study compared to non-IBD controls, but this may be false positive (see multiple testing). Previously published dietary intake assessments in recently diagnosed IBD patients from Netherlands, and CD patients in remission from Canada found similar results (67, 69). Both studies reported that intakes of energy, E% from fat, SFA and carbohydrates did not differ between IBD patients and the control groups. On the other hand, they reported significant differences in intakes of E% from alcohol, PUFA and MUFA in CD and protein in UC (67, 69). The differences found across the studies may be explained by differences in the control groups and the use of dietary assessment methods. The control groups in both the Canadian and the Dutch studies were samples from the general population, unlike the control group in the present study. Geerling et al used a diet history applied by an interviewer, where food intakes were assessed for one month. Furthermore, they did not stratify by gender (67). In Taylor et al, the prospective method weighed food record was used (69).

Lower food intake and undernutrition might be associated with weight loss, a common finding in IBD patients (18, 19, 67). We found that 18 IBD patients (2.5%) in the present study were categorized as underweight according to WHO (124). On the other hand, 45% of IBD patients had a BMI>25kg/m², classified as overweight by WHO (124). The mean BMI for men and women in the general Norwegian population from Norkost 3 were 26.3 kg/m² and 24.6 kg/m², respectively (111). A recent report from the Norwegian Institute of Health (FHI) with data from a representative sample of Norwegian adults showed that 59% of men and 57% of women had a BMI>25 kg/m² (125). Even though results from this report are based on self-reported data, they indicate the growing trend of overweight in the general population. Overweight and obesity in IBD patients seem to follow the same trend as in the general population, especially in patients with UC (126).

E% from macronutrients were mostly in line with NNR2012 (112). Though the E% from saturated fat (13 E%) was higher and E% from carbohydrates (43 E%) was lower in IBD patients than what is recommended (112). From the FFQ validity study, it is known that E% from carbohydrates was overestimated (66). Consequently, we expect the intake of carbohydrate to be even lower than reported. Since IBD patients often suffer from bowel-related symptoms such as bloating, diarrhea and stomach pain, they might also restrict their carbohydrate intakes (127). Some patients may misclassify their symptoms and describe them as allergies to certain foods. This is due to interchangeable symptoms between IBD, IBS, celiac disease and non-celiac gluten sensitivity (NCGS) (127).
After a period on gluten-free diet, a small group of IBD patients reported less symptoms and calmed disease burst (127). In addition to gluten, bread and grain products are sources to FODMAPs that may be responsible for the improvement of symptoms following the gluten-free diet. This is due to lower FODMAP content in gluten-free products than corresponding products containing gluten (32).

5.2.2 Micronutrients

The intakes of micronutrients in CD and UC were overall quiet similar to intakes in non-IBD controls for both men and women, including and excluding supplements. Compared to the NNR 2012 recommendations, the overall mean intakes of micronutrients in IBD patients from both genders were within recommended levels (112). However, iron intake in women and vitamin D in both genders were lower than recommended.

Intakes of vitamin B_{12} and selenium excluding supplements were higher in women with CD and UC compared to controls. This might either be an actual difference linked to the significantly higher consumption of fish and shellfish in IBD patients compared to controls, or a false positive result. Fish and shellfish are considered good dietary sources to both selenium and vitamin B_{12} (112). Selenium intake in Canadian CD patients was higher for both genders in comparison to participants in our sample (69). Dietary selenium content differs remarkably according to its concentration in the soil. Crops grown in the Nordic countries have insignificant amounts of selenium, whereas those imported from North America are plentiful sources (112).

From our results of using the RI values from NNR 2012 as cut-offs, the highest proportions of patients with intakes below RI were found in selenium (previously discussed), vitamin D, calcium, iron and folate which. However, the risk of over- and underreporting may give less reliable results. Additionally, we did not have any blood sample data to decide if insufficient intakes were reflected in lower blood levels. Vitamin D and iron intakes were also reported to be low in the general Norwegian population (111), and this is likely to be the case we in Norwegian IBD patients, too. Therefore, vitamin D and iron are discussed in detail below.

Vitamin D

Sufficient vitamin D levels have always been challenging in the population of Norway and other Nordic countries, because of long winter and lack of sunlight needed for vitamin D production in the skin (128). Reported values from Norkost 3 for the general population showed vitamin D intakes lower than the lowest recommended intake of 10 µg (111). Even with supplements, only patients with UC had median intakes of vitamin D within recommendations. Only 32% of IBD patients (0 %>75 years) had an intake >RI without supplements, which increased to 56% when including supplements (4 of 5 > 75 years). Taylor et al reported a very low intake of vitamin D in Canadian CD patients (3 µg/day in men and 2.5 µg/day in women) compared to the general population (5.9 and 5.0 µg/day for men and women, respectively) (69). Similar findings were found in Italy, where mean serum vitamin D levels in all patients were categorized as insufficient (18).

Vitamin D deficiency is considered a risk factor to development of low bone mineral density (126) . It is also essential for the function of the immune system; both the innate and the adaptive systems (20). The epithelial barrier of the gut can be maintained and restored using some junctional proteins secreted in response to vitamin D (11). It is not fully understood whether vitamin D deficiency, associated with both lower intake and sun exposure, is a causative factor or a result of IBD (129). There is evidence linking vitamin D levels and vitamin D supplementation to the quality of life in both CD and UC patients (126).

Dietary sources to vitamin D are limited and include mainly fatty fish like salmon, sardines, mackerel and fish oil (112, 129). As much as 4% of IBD patients and 10% of non-IBD controls reported eating no fish, of whom more than 50% were women. This might indicate the need for other solutions to increase vitamin D intakes, not relying on fish intake as the only source.

In Norway, as well as other countries, dietary fortification was adapted as a strategy to increase vitamin D consumption in the population (128). Today, some butter types and all margarines in addition to some semi-skimmed milk types are fortified. However, this is a narrow range of products fortified with small doses (128). Supplementation is recommended in high-risk groups such as patients with IBD, specifically under corticosteroid treatment known to affect bone deterioration. Additional benefits of vitamin D supplementation in individuals with deficiency, including IBD patients will ensure intakes in line with recommendations and restore normal serum levels of vitamin D (129).

Iron

Insufficient iron intake (<RI) was more prevalent in premenopausal women (79%) compared to postmenopausal women (30%) in the IBSEN III study. Inadequate iron intakes were also more prevalent in women with IBD compared to men with IBD. These differences between genders were persistent even with supplements. Both women with IBD and women from Norkost 3 had mean iron intakes (11 and 9.9 mg/day, respectively) below recommendations of 15 mg/day. In the studies from Geerling et al and Taylor et al, men and women with CD (69) and IBD (67) had iron intakes (≥13 mg/day) similar to the general population, and higher than IBD patients from the present study. Iron deficiency is challenging in IBD patients, and has been reported in the literature to range from 36 to 90% (20).

Thirty-one out of 47 IBD patients in the present study, who reported no meat consumption were women. Meat is rich in the so-called heme iron, which has three to six folds more bioavailability than non- heme iron (130). The main sources of iron in the Nordic diet are however, cereal products. Less iron has traditionally been consumed from animal sources, such as meat (112). This may be considered as positive according to IBD risk. A recent review by Wark et al found that increased consumption of red and processed meat was associated with increased risk of flares in patients with UC. However for CD, no significant differences in disease activity was observed following a randomization of patients to low or high meat intakes for 49 weeks (11).

Anemia, caused by iron deficiency is considered as the number one complication in IBD patients. It can be difficult to discover, as it overlaps with inflammation related anemia (20). Many factors are involved in determination of iron status in IBD patients including insufficient intakes from dietary sources, blood losses in feces caused by inflammation and reduced absorption from the gut (20). Since IBD patients are exposed to iron loss, dietary intake alone might not cover the daily recommended intakes. Supplementary iron is recommended to these patients, but with attention to type of administration (131). Oral supplements might have poor tolerance in IBD patients with side effects such as abdominal pain, nausea and diarrhea. High iron doses that does not become absorbed can lead to toxicity and worsen the inflammation. Therefore, the European Crohn's and Colitis Organization (ECCO) recommends intravenous infusion as an alternative way to give iron supplementation in IBD (131).

5.2.3 Dietary intakes compared to the Norkost 3

Since there were some limitations related to the control group in the present study (see 5.1.1), we chose to make an additional comparison of nutrient intakes to the Norkost 3. Overall, dietary intakes of energy and E% from macronutrients for both genders with IBD in the IBSEN III study were close to those reported for the general Norwegian population in Norkost 3 (111). Exceptions were lower E% from alcohol in IBD patients, and higher E% from total fat, mainly from MUFA. For micronutrients, vitamin D, C and folate were higher in IBD patients. We should be cautious when making such comparisons between studies, due to the use of different dietary assessment methods (see 5.1.1). FFQs are more suitable to rank individuals than to give exact measurements of absolute intakes (117). However, for the difference seen in E% for alcohol, we suppose it might reflect an actual difference, as IBD patients often avoid alcoholic beverages (14, 16).

5.3 FODMAP

5.3.1 FODMAP intake in Norwegian IBD patients

In the present study, total intakes of FODMAP and intakes of the subgroups fructan, GOS, excess fructose, lactose and polyols in gram/day were not significantly different between IBD patients and non-IBD controls.

To evaluate the internal validity of our FODMAP compilation work, we assessed the FODMAP intake in those who made dietary changes after symptom debut and those who did not make changes, separately. We found that participants who reported to adopt dietary changes that altered dietary FODMAP content had significantly lower intakes of total FODMAP, fructan, excess fructose, lactose and polyols. Moreover, we made a comparison with previous publications from other countries to assess if FODMAP intakes in our present study were realistic. Studies from patients with IBD were sparse, but we included one that analyzed intakes of fructan in patients with CD (132). The others were three studies of patients with IBS and one study from Spain that included a large cohort of healthy adults (39, 117, 133, 134). As illustrated in **Figure 6**, intakes of total FODMAP reported in different publications ranged from 17 g/day in Staudacher et al to 29.4 g/day in O'Keeffe et al (39, 134). The intake of total FODMAP in IBD patients in the present study was not far from the upper range reported in O'Keeffe et al (134). Men had higher FODMAP intakes than women in the present study, a finding also seen in Nybacka et al, which is likely due to higher energy intakes in men.

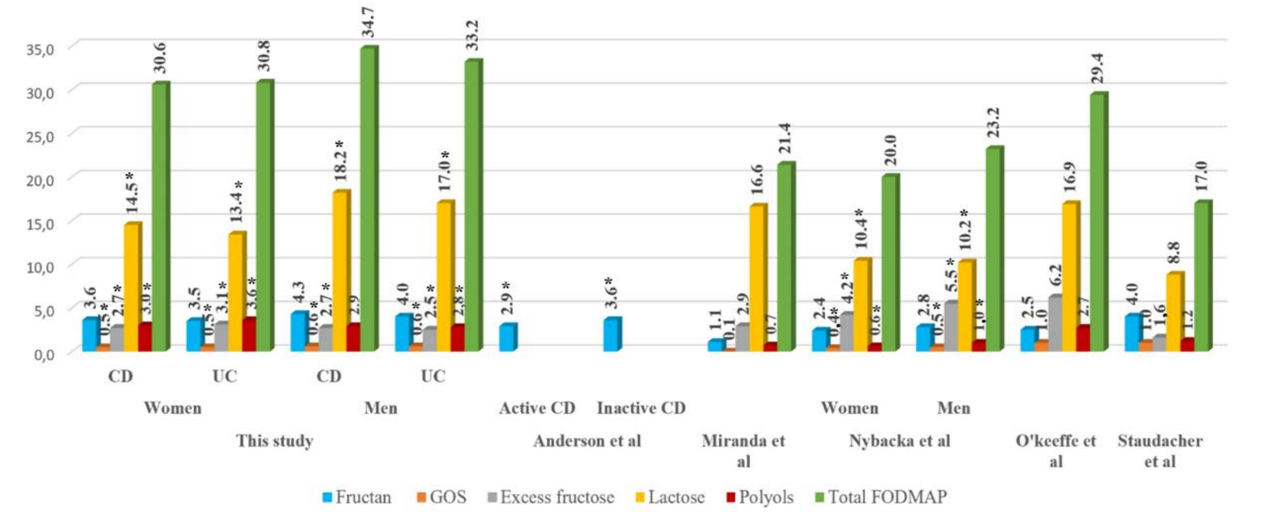

Figure 6. FODMAP intake of adults from different populations and countries. This study (n=390, 18-80 years, IBD patients, Norway), Anderson et al, 2015 (n=197, 37.4 years, Crohn's disease, UK), Miranda et al, 2020 (n=933, 18-74 years, normal population, Spain), Nybacka et al, 2019 (n=197, 37 years, Irritable bowel syndrome, Sweden), O'Keeffe et al, 2018 (n=19, 49 years, Irritable bowel syndrome, UK), Staudacher et al, 2020 (n=130, 35.6 years, Irritable bowel syndrome, UK). GOS: galactooligosaccharides, FODMAP: fermentable oligo-, di-, monosaccharides & polyols, excess fructose= fructose-glucose, CD: Crohn's disease, UC: Ulcerative colitis, *presented as median.

The influence of FODMAP subgroups on total FODMAP intake showed the same trend in all studies, with lactose being the subgroup contributing the most and GOS the least (39, 117, 133, 134). Fructans, excess fructose and polyols had different ranks across the study populations. In the present study and in Staudacher et al, fructans had second highest load followed by excess fructose (39). This was opposite of what was found in the studies by O'Keeffe et al and Miranda et al, where excess fructose contributed more to the total FODMAP intake than fructans (133, 134). This might be explained by differences in food cultures and dietary habits across countries, which affect the consumption of different foods and beverages.

Today, there are still knowledge gaps regarding FODMAP contents in food from specific regions or countries, which affects the accuracy of the intake measurements (133). Furthermore, we agree with Miranda et al regarding the challenges associated with the search for some food items and FODMAP subgroups (especially fructans and GOS). These are often not included in food composition databases and seldom reported (133).

5.3.2 FODMAP sources

It was expected that milk and dairy products were main contributors to total FODMAP intake in all disease and control groups, since lactose had highest contribution. The other food groups gave nearly the same amount (in %) of FODMAP in IBD as well as in non-IBD controls.

In order to give dietary guidance to Norwegian IBD patients regarding LFD, knowledge about contribution from specific food items to total FODMAP intakes is needed. For this reason, we created the top ten lists for food items influencing the intake of fructans, GOS, excess fructose, lactose and polyols. This was also done in the study by Miranda et al, but only for fructans, excess fructose and lactose (133). However, their values are restricted to application in the Spanish population, as authors from other countries reported different values and FODMAP sources (133). FODMAP intake and sources differ according to food processing techniques and ingredients in composite dishes (see also 5.1.1 internal validity) (32, 133).

A comparison between the Spanish population and the IBSEN III study population showed that the top sources of lactose in both studies were different types of milk and yoghurt products (133). However, in the present study chocolate was the fourth highest contributor to lactose. This was not found in the Spanish study (133). The remaining five places were completely different, which emphasizes the differences seen across food cultures. Brown whey cheese is commonly used in Norway either as spread or added during cooking (135). This may explain why it was the 6th food source to lactose in the present study. Onion and bread topped the lists of food sources to fructans for both populations, whereas broccoli, cereals, pasta, vegetable mix, grains and peas contributed with lesser amounts. This was not the case in the study by Miranda et al, as the participants in their study consumed more fructans from garlic, leak, baked goods and fruit (133).

The last FODMAP subgroup compared was excess fructose, as no publications including GOS and polyols were found. The IBSEN III study population consumed mainly excess fructose from different kinds of fruit (fresh and dried), which was consistent with findings from Spain (133). But the Spanish population had in addition honey, white wine and white bread as significant sources. Regardless of the differences found between the two populations as explained above, there were many similar observations. This may be due to some common methodological aspects such as using previously published FODMAP values. However, we suppose that Miranda et al have more accurate values, since they analyzed fructan contents in garlic, onion and cereal products most often consumed by the Spanish population. Furthermore, they used a specific designed software, which enabled them to calculate excess fructose in dishes and meals and to define a FODMAP threshold compatible with the standard Spanish diet (133).

5.3.3 FODMAP intake and use of pre-, and probiotics

In the present study, 19% of participants reported to use pre-, and probiotics supplements. There were no difference in use between IBD patients and non-IBD controls. More women than men used these supplements, both in the disease and control groups, which was in line with previously reported findings (14) .

Prebiotics are substances that stimulate the growth and activity of bacteria in the gut that are believed to have beneficial health effects. The most investigated prebiotic is the fructan subtype inulin (132). Probiotics, on the other hand are bacterial strains suggested to have health promoting effects in the gut (17). These are found in dietary sources that might also contain FODMAPs, like fermented milk, cheese, ice cream and yoghurt in addition to cereal products and soy-based products (136). From our results, we noticed a significantly higher intake of excess fructose and total FODMAP in women when separated in users and non-users of pre-, and probiotics. According to this, we think that inclusion of pre- and probiotic users in the FODMAP intake measurement might have resulted in higher intakes in the present study, compared to what we expect if they were excluded.

5.4 FODMAP intake and IBS diagnosis in IBD patients

We did not find any differences in intake of total FODMAP, nor FODMAP subgroups between IBD patients and non-IBD controls in regard to IBS diagnosis. FODMAP intake did not show any association to IBS prevalence. These results were still consistent, when we compared patients who made dietary changes after symptom debut and those who did not. An exception was however observed for fructans, which was significantly associated to IBS in those who changed their diet (p=0.009 in adjusted model). The IBS diagnosis was more frequent in those who changed their diet. This was expected, since patients with bowel related symptoms are more likely to try different dietary strategies in order to achieve symptom relief. Dietary changes included in the analysis were the gluten free, lactose free and LFD. We did not test for the LFD alone, due to low sample size (n=36), which reduce the statistical power to detect real differences. Additionally, we could risk to miss participants who adopted other dietary changes that also altered FODMAP intake. Both gluten free and LFD may contribute to lower fructan intakes as discussed previously (see carbohydrates) (32), which may explain the significant association between fructan and IBS.

In a study by Anderson et al from UK, they reported the intakes of fructans in a large sample of CD patients, with active and inactive disease (see **Figure 6**) (132). They found lower intakes of fructan in patients with active disease than inactive disease. Fructan intake in patients with inactive disease was similar to IBD patients in the IBSEN III study. We agree with Andersen et al in that patients with severe symptoms avoid food they think may worsen their symptoms. Many CD patients reported foods containing fructans such as wheat and breads, vegetables and cereals as major symptomatic triggers (132). A randomized controlled cross-over study by Cox et al included 29 IBD patients, and investigated the effect of consumption of specific doses of GOS, polyols and fructans (12 g/day) against a glucose placebo on IBS like symptoms (137). They found significantly higher symptom incidence and severity as well as less number of patients who reported symptom relief during the three-day fructan challenge compared to glucose (137).

Fructans has been linked to symptoms caused by abdominal gas (flatulence, pain and bloating). This might be explained by their high colonic fermentation rate resulting in hydrogen gas production (137). The fructan dose used in the study from Cox et al was approximately three times higher than what has been reported to be ingested through diet (see **Figure 6**), which may have affected the results from Cox et al (137).

Today, most of the published studies investigating the relationship between FODMAP intake and IBS in IBD patients were of interventional design (35, 43, 44, 46, 47). Outcomes were often compared after a period of either following a LFD or a standard diet (a diet higher in FODMAP content). Different outcomes have been investigated such as IBS symptoms, quality of life, disease activity, and biological markers of inflammation (35, 43, 44, 46, 47). Common findings in both short (35, 43, 47, 48) and long term (49) studies include significant reductions in IBS related symptoms such as abdominal pain, bloating, flatulence, incomplete evacuation, borborygmi, and lethargy. In contrast, the effects of altered FODMAP intake on IBD disease activity, quality of life and inflammation markers are contradictory (43, 46, 47).

In a study by Prince et al, a higher proportion of IBD patients reported improved stool frequency and consistency after a period with LFD. Reports of both mixed and loose stool consistency decreased, while incidence of normal stool increased and hard stool was not affected (35). According to our results, we observed significantly higher frequency of mixed stool type, diarrhea and constipation in the group that reported to following a gluten-, lactose free and a LFD compared to unchanged diet. We cannot directly compare our results to those from Prince et al, due to differences in study design and study population (35). From our study design, we were not able to define if the dietary changes were a cause or a result to fecal disturbances. However, we assume that IBD patients in the present study most likely changed their diet to achieve symptom improvement.

In published studies, the effect of a LFD was mainly investigated in IBD patients in remission or with a mild disease (43, 44, 46-48). This may be a conscious choice, as it reduces the risk of incorrect presumption of symptoms as either caused by inflammation or IBS related, as the symptoms are similar (35). In the present study, we included newly diagnosed patients that might have increased inflammation rates compared to patients in remission. Furthermore, we did not have data on disease activity or biological markers, which we could use in order to categorize patients and perform additional analyses. This could have impacted the results regarding the association between FODMAP intake and IBS diagnosis (35).

6 Conclusion

The FODMAP compilation work conducted in this study has enabled us to assess FODMAP intake in gram/day for the first time in a Norwegian IBD population. Furthermore, the incorporation of FODMAP values into the AE-18 food database in KBS enabled the calculation of FODMAP intakes in the IBSEN III population, but might be applied for other populations using the same FFQ.

The differences in intakes of macro-, micronutrients and food groups between IBD patients and non-IBD controls were small. Similar dietary restriction behavior between the groups may explain this. The overall intakes of energy, macro- and micronutrients in newly diagnosed IBD patients from the IBSEN III study were in line with the NNR 2012 recommendations. The intake of micronutrients vitamin D in both genders and iron in women seem to be challenging in IBD patients as reported for the general population from Norkost 3. The low intakes warrant close monitoring of vitamin D and iron levels in IBD patients.

FODMAP intakes were quiet similar for IBD patients and non-IBD controls, with the same trend in contribution from different food groups. We assessed the most common food sources for FODMAPs in IBD patients, which might be useful knowledge informing future dietary guidelines development for IBD patients.

There were no associations between FODMAP intake and IBS diagnosis in IBD patients in the present study. However, dietary changes influencing fructan content in the diet showed an association with IBS diagnosis.

Suggestions for future research

1) To extend the FODMAP content compilation work, and make contents obtainable for all food items in the AE-18 database. This will make calculation more accurate, reliable, and thus valuable in investigating FODMAP intake in different groups in the Norwegian population.
2) To connect blood sample results data to micronutrient intake data, This will help identifying possible deficiencies more accurately.
3) To include a sample from the general population as a control group in future studies investigating IBD patients.
4) To investigate associations between LFD and IBD disease activity markers, inflammatory markers and quality of life scores. It would also be of interest to assess which fructan rich foods were exactly restricted in the IBSEN III population, as this was positively associated with IBS diagnosis in the present study.

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8 APPENDIX

Appendix I: Overview of the ROME IV criteria used in IBS diagnosis*

A recurrent abdominal pain on an average of at least 1 day/week for the previous 3 months, in association with at least two of the following:
• Linked to the bowel movement • Linked to changed stool frequency • Linked to changed stool form

(The criteria should be fulfilled for the last 3 months with a minimum of 6 months since symptom debut). * Modified from Lacy et al. 2017 (42).

Appendix II: Detailed list of terms and keywords used during the literature search for FODMAP values

- GOS content in food
- FODMAP in vegetables
- FOS in nuts
- Measurement of FODMAP in food
- Measurement of FOS and inulin in food
- Measurement of lactose in food
- Measurement of short chain carbohydrates in food
- Quantification of FODMAP in fruit and vegetables
- Polyol content in fruit
- Sugar content in food
- Fructan content in nuts
- Fructans in vegetables
- Fructans in fruit
- Fructans in dried fruit
- Fructan content in grains
- Fructans in wheat
- Fructans in cereals
- Polyols in food
- Sugar quantification in food
- Fructan content in linseed
- Fructan in pine nuts
- Lactose content in cheese
- Polyol content in prunes

Appendix III: Overview of values of FODMAP subgroups (fructans, GOS, excess fructose, lactose & polyols) from published literature

Fructans		
Food	**Value**	**Reference**
Alcopop	**0** g	Fineli: Finnish food database (54)
All Bran cereal	**2.35** g/100 g f.w	Biesiekierski et al 2011 (28)
Almonds	**0.85** g/100 g f.w*	Biesiekierski et al 2011 (28)
Anchovy	**0** g	Norwegian food database (50)
Apple	0 g/100 g f.w 0.15 g/100 g f.w 0.01 g/100 g f.w Mean: **0.05** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Avocado	**0** g	Muir et al 2007 (98)
Bacon	**0** g	Fineli: Finnish food database (54)
Banana	0 g/100 g f.w 0.81 g/100 g f.w 0.70 g/100 g f.w 0.29 g/10 g f.w Mean: **0.45 g**	Muir et al 2007 (98) Shalini et al 2015 (101) Van Loo et al 1995 (104) Judprasong et al 2011 (88)
Barley	**1.38** g/100 g d.w	Ispiryan et al 2020 (86)
Beer, alcohol free	**0** g	Fineli: Finnish food database (54)
Beer, lager	**0** g	Fineli: Finnish food database (54)
Beer, light	**0** g	Fineli: Finnish food database (54)
Bell pepper (green, yellow, red)	**0** g	Muir et al 2007 (98) & Jovanovich-Malinovska et al 2014 (87)
Blueberry	0.44 g/100 g f.w 0.50 g/100 g f.w 0 g/100 g f.w Mean: **0.31** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Bread, white (loff)	0.68 g/100 g f.w 0.14 g/100 g f.w Mean: **0.41** g	Biesiekierski et al 2011 (28) Ispiryan et al 2020 (86)
Bread, wholegrain	**0.58** g/100 g f.w	Biesiekierski et al 2011 (28)
Broccoli	0.78g/100 g f.w 0.79 g/100 g f.w Mean: **0.78** # g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Brussels sprouts	0.82 g/100 g f.w 0.55 g/100 g f.w Mean: **0.68** # g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Cabbage	0.46 g/100 g f.w 0.82 g/100 g f.w Mean: **0.64** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Candy, hard	**0** g	Fineli: Finnish food database (54)
Candy, mix	**0** g	Fineli: Finnish food database (54)
Carrot	**0.04** g/100 g f.w	Judprasong et al 2011 (88)
Cauliflower	**0** g#	Jovanovich-Malinovska et al 2014 (87)
Caviar	**0** g	Fineli: Finnish food database (54)
Cheese, Brie	**0** g	Norwegian food database (50) & Food Standards Australia & New Zealand (55)
Cheese, Cottage	**0** g	Norwegian food database (50) & Food Standards Australia & New Zealand (55)

Cheese, Cream	**0** g	Fineli: Finnish food database (54)
Cheese, Cream light	**0** g	Fineli: Finnish food database (54)
Cheese, mature	**0** g	Norwegian food database (50) & Food Standards Australia & New Zealand (55)
Cheese, mature, Norvegia	**0** g	Norwegian food database (50) & Food Standards Australia & New Zealand (55)
Cheese, Whey	**0** g	Norwegian food database (50)
Cheese, Whey, Gulbrandsdalsost	**0** g	Norwegian food database (50)
Cherries	**0.32** g/100 g f.w#	Jovanovich-Malinovska et al 2014 (87)
Chicken, breast	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, thighs	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, with skin	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chips, potato	**0.22** g/100 g f.w	Biesiekierski et al 2011 (28)
Chives	**0 g#**	Muir et al 2009 (99) & Capmbell et al 1997 (73)
Clementine	**0** g	Muir et al 2007 (98)
Cod, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cod, fillet, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cofee, boiled	**0** g	Fineli: Finnish food database (54)
Coffee, cappuccino	**0** g	Fineli: Finnish food database (54)
Coffee, coffee latte	**0** g	Fineli: Finnish food database (54)
Coffee, espresso	**0** g	Fineli: Finnish food database (54)
Coffee, filtered	**0** g	Fineli: Finnish food database (54)
Coffee, instant	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cordial, fun light	**0** g	Funlight.no/products (59)
Corn flakes	**1.07** g/100 g f.w	Biesiekierski et al 2011 (28)
Corn starch	**0** g	Ispiryan et al 2020 (86)
Corn, sweet	**0** g	Muir et al 2007 (98)
Cream, sour 10% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 20% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 35% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, whipping	**0** g	Norwegian food database (50)
Crisp bread, light	**0.77** g/100 g f.w	Biesiekierski et al 2011 (28)
Crisp bread, dark	**0.55** g/100 g f.w	Biesiekierski et al 2011 (28)
Crisp bread, wholegrain rye with yeast	**4.60** g/100 g f.w	Biesiekierski et al 2011 (28)
Cucumber	**0** g	Muir et al 2007 (98)
Currant, black	**0.08** g/100 g f.w#	Jovanovich-Malinovska et al 2014 (87)
Currant, red	**0.35** g/100 g f.w#	Jovanovich-Malinovska et al 2014 (87)
Drink, alcoholic	**0** g	Norwegian food database (50)
Durumwheat/Semolina	1.20 g/100 g f.w 1.17 g/100 g f.w Mean: **1.19** g	Ispiryan et al 2020 (86) Ziegler et al 2016 (110)
Egg, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Energy drink, battery	**0** g	Fineli: Finnish food database (54)
Fish, balls	**0** g	Norwegian food database (50)
Flour, rye	**4.40** g/100 g d.w	Karppinen et al 2003 (90)
Flour, wheat, white	1.50 g/100 g d.w	Haskå et al 2008 (81)

	1.19 g/100 g d.w 1.33 g/100 g d.w 1.49 g/100 g d.w Mean: **1.38** g	Ispiryan et al 2020 (86) Ispiryan et al 2019 (85) Ziegler et al 2016 (110)
Flour, wheat, wholemeal	1.97 g/100 g d.w 1.88 g/100 g d.w 1.87 g/100 g d.w Mean: **1.91** g	Ziegler et al 2016 (110) Ispiryan et al 2020 (86) Ispiryan et al 2019 (85)
Garlic	17.4 g/100 g f.w 23.3 g/100 g f.w Mean: **20.3** g	Muir et al 2007 (98) Judprasong et al 2011 (88)
Grapes	0 g/100 g f.w 0 g/100 g f.w 0.08 g/100 g f.w 0.01 g/100 g f.w Mean: **0.02** g#	Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Ham, cooked	**0** g	Norwegian food database (50)
Herring, raw	**0** g	Fineli: Finnish food database (54)
Honey	0.04 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.01** g#	Hogarth et al 2000 (84) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Ice cream, vanilla	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Juice, apple	**0.04** g/100 g f.w	Hogarth et al 2000 (84)
Juice, grape	**0** g	Fineli: Finnish food database (54), Norwegian food database (50) & Hogarth et al 2000 (84)
Juice, orange	**0** g	Food Standards Australia & New Zealand (55)
Kiwi fruit	**0** g	Muir et al 2007 (98)
Leek	**0.71** g/100 g f.w **3.0** g/100 g f.w Mean: **1.8** g	Judprasong et al 2011 (88) Van Loo et al 1995 (104)
Lettuce	0.19 g/100 g f.w 0.33 g/100 g f.w Mean: **0.26** g#	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Linseed	**0.85** g/100 g f.w*	Biesiekierski et al 2011 (28)
Mackerel, raw	**0** g	Norwegian food database (50)
Margarine/butter	**0** g	Fineli: Finnish food database (54)
Mayonnaise, original	**0** g	Food Standards Australia & New Zealand (55)
Meat, beef, fillet	**0** g	Norwegian food database (50)
Meat, pork, chop	**0** g	Norwegian food database (50)
Melon, honeydew	**0.21** g/100 g f.w	Muir et al 2007 (98)
Milk, chocolate	**0** g	Food Standards Australia & New Zealand (55)
Milk, full-fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, powder	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Milk, semi skimmed	**0** g	Food Standards Australia & New Zealand (55)
Milk, semi skimmed 0,5%fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, skimmed	**0** g	Food Standards Australia & New Zealand (55)
Muesli with fruit	**2.04** g/100 g f.w	Biesiekierski et al 2011 (28)
Mustard	**0** g	Chumpiatzi et al 2018 (77)
Nectarine	0.59 g/100 g f.w	Muir et al 2009 (99)

	0.89 g/100 g f.w Mean: **0.74** g#	Jovanovich-Malinovska et al 2014 (87)
Oat	0 g/100 g d.w 0.40 g/100 g f.w 0.32 g/100 g f.w Chosen: **0** g	Ispiryan et al 2020 (86) Food Standards Australia & New Zealand (55) Biesiekierski et al 2011 (28)
Onion powder	4.50 g/100 g f.w 4.17 g/100 g f.w Mean: **4.30** g	Campbell et al 1997 (73) Hogarth et al 2000 (84)
Onion, raw	6.30 g/100 g f.w 10.2 g/100 g f.w Mean: **8.27** g	Muir et al 2007 (98) Judprasong et al 2011 (88)
Orange	0 g/100 g f.w 0 g/100 g f.w 0.03 g/100 g f.w Mean: **0.01** g	Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Campbell et al 1997 (73)
Pastille, artificially sweetened	**0** g	Fineli: Finnish food database (54)
Pear	0 g/100 g f.w 0.56 g/100 g f.w 0.02 g/100 g f.w Mean: **0.19** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Peas	0.01 g/100 g f.w 0 g/100 g f.w Mean: **0.005** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Pineapple	0 g/100 g f.w 0.1 g/100 g f.w Mean: **0.05** g#	Chumpiatzi et al 2018 (77) Muir et al 2009 (99)
Plum	0.09 g/100 g f.w 0.02 g/100 g f.w Mean: **0.05** g#	Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Potato flour/starch	**0** g	Ispiryan et al 2020 (86)
Potato, boiled	**0** g	Judprasong et al 2011 (88) & Muir et al 2007 (98)
Potato, French fries	0 g/100 g f.w 0 g/100 g f.w 0.27 g/100 g f.w Mean: **0.09** g#	Judprasong et al 2011 (88) Muir et al 2009 (99) Chumpiatzi et al 2018 (77)
Potato, fried	**0** g	Judprasong et al 2011 (88) & Muir et al 2007 (98)
Pudding, almond	**0** g	Fineli: Finnish food database (54)
Pulses, dry	**0.55** g/100 g f.w	Biesiekierski et al 2011 (28)
Pumpkin	**0** g	Muir et al 2007 (98)
Raisins	**5.50** g/100 g f.w	Camire et al 2003 (72)
Raspberry	0.30 g/100 g f.w 0.51 g/100 g f.w 0.02 g/100 g f.w Mean: **0.28** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Campbell et al 1997 (73)
Rice, boiled	**0** g	Biesiekierski et al 2011 (28)
Rye	3.61 g/100 g d.w	Ispiryan et al 2020 (86)

	4.10 g/100 g Chosen: **3.61** g	Food Standards Australia & New Zealand (55)
Salmon, smoked and cured	**0** g	Norwegian food database (50)
Salmon/Trout, raw	**0** g	Norwegian food database (50)
Sauce, soya	**0** g	Food Standards Australia & New Zealand (55)
Sauce, vanilla	**0** g	Fineli: Finnish food database (54)
Shellfish, boiled	**0** g	Norwegian food database (50)
Soda, light	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Soda, original	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Spaghetti, boiled	0.34 g/100 g f.w 0.32 g/100 g f.w Mean: **0.33** g	Biesiekierski et al 2011 (28) Ispiryan et al 2020 (86)
Spinach	**0.14** g/100 g f.w	Muir et al 2007 (98)
Spread, mackerel in tomato	**0** g	Norwegian food database (50) (estimated using ingredients)
Spread, peanut butter	0,02 g/100 g f.w 0 g/100 g f.w Mean: **0.01** g#	Chumpiatzi et al 2018 (77) Food Standards Australia & New Zealand (55)
Spread, salmon in box	**0** g	Norwegian food database (50)
Steak, deer	**0** g	Norwegian food database (50)
Steak, pork	**0** g	Norwegian food database (50)
Strawberry	0 g/100 g f.w 0.09 g/100 g f.w Mean: **0.04** g#	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Sugar, icing	**0** g	Food Standards Australia & New Zealand (55)
Sugar, white	**0** g	Food Standards Australia & New Zealand (55)
Sunflower seeds	0.85 g/100 g f.w* 2.09 g/100 g f.w Mean: **1.47** g	Biesiekierski et al 2011 (28)
Sweetener, natreen	**0** g	https://www.natreen.no/produkter/natreen-original/sotningstabletter/ (60)
Tea, black	**0** g	Norwegian food database (50)
Tea, green	**0** g	Norwegian food database (50)
Tea, herbal	**0** g	Fineli: Finnish food database (54)
Tomatoes	0.09 g/100 g f.w 0 g/100 g f.w Mean: **0.04** # g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Tuna, canned	**0** g	Norwegian food database (50)
Turnip	**0** g	Muir et al 2007 (98)
Water, mineral	**0** g	Norwegian food database (50)
Water, tap	**0** g	Norwegian food database (50)
Wheat, bran	3.40 g/100 g d.w 3.30 g/100 g d.w 3.70 g/100 g d.w Mean: **3.47** g	Ispiryan et al 2020 (86) Kamal-Eldin et al 2009 (89) Haskå et al 2008
Wine, fortified	**0** g	Fineli: Finnish food database (54)
Wine, liquor	**0** g	Norwegian food database (50)
Wine, red	**0** g	Fineli: Finnish food database (54)
Wine, white	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, drink flavored	**0** g	Fineli: Finnish food database (54)

Yoghurt, fruit	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, fruit, light	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, plain	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, Skyr (blueberry)	**0** g	Fineli: Finnish food database (54)
Yoghurt, Skyr w/taste	**0** g	Fineli: Finnish food database (54)

*Reported as a mix of almonds, sunflower seeds and linseed, # reported as fructooligosaccharides (FOS), f.w: fresh weight, d.w: dry weight.

GOS		
Food	**Value**	**Reference**
Alcopop	**0** g	Fineli: Finnish food database (54)
All Bran cereal	**1.32** g/100 g f.w	Biesiekierski et al 2011 (28)
Almonds	**0.58** g/100 g f.w*	Biesiekierski et al 2011 (28)
Anchovy	**0** g	Norwegian food database (50)
Apple	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Avocado	**0** g	Muir et al 2009 (99)
Bacon	**0** g	Fineli: Finnish food database (54)
Banana	**0** g	Muir et al 2009 (99) & Chumpiatzi et al 2018 (77)
Barley	0.56 g/100 g d.w 0.24 g/100 g Mean: **0.40 g**	Ispiryan et al 2020 (86) Henry et al 1989 (82)
Beer, alcohol free	**0** g	Fineli: Finnish food database (54)
Beer, lager	**0** g	Fineli: Finnish food database (54)
Beer, light	**0** g	Fineli: Finnish food database (54)
Bell pepper (green, yellow, red)	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Blueberry	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Bread, white (loff)	0.2 g/100 g f.w 0.01 g/100 g f.w Mean: **0.10** g	Biesiekierski et al 2011 (28) Ispiryan et al 2020 (86)
Bread, wholegrain	**0.55** g/100 g f.w	Biesiekierski et al 2011 (28)
Broccoli	0.11g/100 g f.w 0.13 g/100 g f.w Mean: **0.12** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Brussels sprouts	**0** g	Jovanovich-Malinovska et al 2014 (87) & Muir et al 2009 (99)
Cabbage	**0** g/100 g f.w	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Candy, hard	**0** g	Fineli: Finnish food database (54)
Candy, mix	**0** g	Fineli: Finnish food database (54)
Carrot	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Cashews, salted	**2.38** g/100 g f.w	Griffin et al 2017 (80)
Cauliflower	**0** g	Jovanovich-Malinovska et al 2014 (87) & Muir et al 2009 (99)
Caviar	**0** g	Fineli: Finnish food database (54)
Cheese, Brie	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Cottage	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Cream	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Cream light	**0** g	Food Standards Australia & New Zealand (55)
Cheese, mature	**0** g	Food Standards Australia & New Zealand (55)
Cheese, mature, Norvegia	**0** g	Norwegian food database (50)
Cheese, Whey	**0** g	Norwegian food database (50)
Cheese, Whey, Gulbrandsdalsost	**0** g	Norwegian food database (50)

Cherries	**0** g	Jovanovich-Malinovska et al 2014 (87)
Chicken, breast	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, thighs	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, with skin	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chips, potato	**0** g	Biesiekierski et al 2011 (28)
Chives	**0** g	Muir et al 2009 (99)
Clementine	**0** g	Muir et al 2009 (99)
Cod, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cod, fillet, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cofee, boiled	**0** g	Fineli: Finnish food database (54)
Coffee, cappuccino	**0** g	Fineli: Finnish food database (54)
Coffee, coffee latte	**0** g	Fineli: Finnish food database (54)
Coffee, espresso	**0** g	Fineli: Finnish food database (54)
Coffee, filtered	**0** g	Fineli: Finnish food database (54)
Coffee, instant	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cordial, fun light	**0** g	Funlight.no/products/ (59)
Corn flakes	**0** g	Biesiekierski et al 2011 (28)
Corn starch	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Corn, sweet	**0** g	Muir et al 2009 (99)
Cream, sour 10% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 20% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 35% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, whipping	**0** g	Norwegian food database (50)
Crisp bread, light	**0** g	Biesiekierski et al 2011 (28)
Crisp bread, wholegrain rye with yeast	**0** g	Biesiekierski et al 2011 (28)
Cucumber	**0** g	Muir et al 2009 (99)
Currant, black	**0** g	Jovanovich-Malinovska et al 2014 (87)
Currant, red	**0** g	Jovanovich-Malinovska et al 2014 (87)
Drink, alcoholic	**0** g	Norwegian food database (50)
Durumwheat/Semolina	**0** g	Ispiryan et al 2020 (86) & Ziegler et al 2016 (110)
Egg, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Energy drink, battery	**0** g	Fineli: Finnish food database (54) & Ringnes.no (56)
Fish, balls	**0** g	Norwegian food database (50)
Flour, wheat, white	0.06 g/100 g d.w 0.21 g/100 g d.w Mean: **0.13** g	Ispiryan et al 2020 (86) Ziegler et al 2016 (110)
Flour, wheat, wholemeal	0.23 g/100 g d.w 0.14 g/100 g d.w Mean: **0.18** g	Ziegler et al 2016 (110) Ispiryan et al 2020 (86)
Garlic	0 g/100 g f.w 0.56 g/100 g f.w Mean: **0.28** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Grapes	**0** g	Muir et al 2009 (99), Chumpiatzi et al 2018 (77), Jovanovich-Malinovska et al 2014 (87) & Shanmugavelan et al 2013 (102)

Ham, cooked	**0** g	Norwegian food database (50)
Herring, raw	**0** g	Fineli: Finnish food database (54)
Honey	**0** g	Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Ice cream, vanilla	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Juice, grape	**0** g	Fineli: Finnish food database (54), Norwegian food database (50) & Hogarth et al 2000 (84)
Juice, orange	**0** g	Food Standards Australia & New Zealand (55)
Kiwi fruit	**0** g	Muir et al 2009 (99) & Shanmugavelan et al 2013 (102)
Leek	**0** g	Jovanovich-Malinovska et al 2014 (87)
Lettuce	0 g/100 g f.w 0.05 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.01** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Shanmugavelan et al 2013 (102)
Linseed	**0.58** g/100 g f.w*	Biesiekierski et al 2011 (28)
Mackerel, raw	**0** g	Norwegian food database (50)
Margarine/butter	**0** g	Food Standards Australia & New Zealand (55)
Mayonnaise, original	**0** g	Food Standards Australia & New Zealand (55)
Meat, beef, fillet	**0** g	Norwegian food database (50)
Meat, pork, chop	**0** g	Norwegian food database (50)
Melon, honeydew	**0** g	Muir et al 2009 (99) & Jovanovich- Malinovska et al 2014 (87)
Milk, chocolate	**0** g	Food Standards Australia & New Zealand (55)
Milk, full-fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, powder	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Milk, semi skimmed	**0** g	Food Standards Australia & New Zealand (55)
Milk, semi skimmed 0,5%fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, skimmed	**0** g	Food Standards Australia & New Zealand (55)
Muesli with fruit	**0.28** g/100 g f.w	Biesiekierski et al 2011 (28)
Mustard	**0** g	Chumpiatzi et al 2018 (77)
Nectarine	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Oat	0.32 g/100 g d.w 0.08 g/100 g 0.34 g/100 g f.w Chosen: **0.32** g	Ispiryan et al 2020 (86) Henry et al 1989 (82) Biesiekierski et al 2011 (28)
Onion, raw	**0.21** g/100 g f.w	Shanmugavelan et al 2013 (102)
Orange	**0** g	Muir et al 2009 (99) & Chumpiatzi et al 2018 (77)
Pastille, artificially sweetened	**0** g	Fineli: Finnish food database (54)
Pear	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Peas	**0** g	Jovanovich-Malinovska et al 2014 (87)
Pine nuts	**0.81** g/100 g f.w	Ruiz-Aceituno et al 2012 (100)
Pineapple	**0** g	Chumpiatzi et al 2018 (77) & Muir et al 2009 (99)
Plum	**0** g	Jovanovich-Malinovska et al 2014 (87)
Potato flour/starch	**0** g	Ispiryan et al 2020 (86)
Potato, boiled	**0** g	Muir et al 2009 (99) & Chumpiatzi et al 2018 (77)
Potato, French fries	**0** g	Muir et al 2009 (99) & Chumpiatzi et al 2018 (77)
Potato, fried	**0** g	Judprasong et al 2011 (88) & Muir et al 2009 (99)
Pudding, almond	**0** g	Fineli: Finnish food database (54)
Pulses, dry	**1.16** g/100 g f.w	Biesiekierski et al 2011 (28)
Raspberry	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)

Rice, boiled	**0** g	Biesiekierski et al 2011 (28) & Chumpiatzi et al 2018 (77)
Rye	0.13 g/100 g d.w 0.08 g/100 g Chosen: **0.13** g	Ispiryan et al 2020 (86) Henry et al 1989 (82)
Salmon, smoked	**0** g	Norwegian food database (50)
Salmon/Trout, raw	**0** g	Norwegian food database (50)
Sauce, soya	**0** g	Food Standards Australia & New Zealand (55)
Sauce, vanilla	**0** g	Fineli: Finnish food database (54)
Shellfish, cooked	**0** g	Norwegian food database (50)
Soda, light	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Soda, original	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Spaghetti, boiled	0 g/100 g f.w 0.01 g/100 g f.w Mean: **0.005** g	Biesiekierski et al 2011 (28) Ispiryan et al 2020 (86)
Spinach	**0** g	Muir et al 2009 (99) & Shanmugavelan et al 2013 (102)
Spread, mackerel in tomato	**0** g	Norwegian food database (50) (estimated using ingredients)
Spread, peanut butter	**0** g	Chumpiatzi et al 2018 (77)
Spread, salmon (canned)	**0** g	Norwegian food database (50)
Steak, deer	**0** g	Norwegian food database (50)
Steak, pork	**0** g	Norwegian food database (50)
Strawberry	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Sugar, icing	**0** g	Food Standards Australia & New Zealand (55)
Sugar, white	**0** g	Food Standards Australia & New Zealand (55)
Sunflower seeds	**0.58** g/100 g f.w*	Biesiekierski et al 2011 (28)
Sweetener, natreen	**0** g	https://www.natreen.no/produkter/natreen-original/sotningstabletter/ (60)
Tea, black	**0** g	Norwegian food database (50)
Tea, green	**0** g	Norwegian food database (50)
Tea, herbal	**0** g	Fineli: Finnish food database (54)
Tomatoes	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Tuna, canned	**0** g	Norwegian food database (50)
Turnip	**0** g	Muir et al 2009 (99)
Water, mineral	**0** g	Norwegian food database (50)
Water, tap	**0** g	Norwegian food database (50)
Wheat	**0.48** g/100 g	Henry et al 1989 (82)
Wheat, bran	**0.41** g/100 g d.w	Ispiryan et al 2020 (86)
Wine, fortified	**0** g	Fineli: Finnish food database (54)
Wine, liquor	**0** g	Norwegian food database (50)
Wine, red	**0** g	Fineli: Finnish food database (54)
Wine, white	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, drink flavored	**0** g	Fineli: Finnish food database (54)
Yoghurt, fruit	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, fruit, light	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, plain	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, Skyr (blueberry)	**0** g	Fineli: Finnish food database (54)
Yoghurt, Skyr w/taste	**0** g	Fineli: Finnish food database (54)

*Reported as a mix of almonds, sunflower seeds and linseed, # reported as fructooligosaccharides (FOS), f.w: fresh weight, d.w: dry weight, GOS: galactooligosaccharides.

Excess fructose		
Food	**Value**	**Reference**
Alcopop	**0** g	Fineli: Finnish food database (54)
All Bran cereal	0.56 g/100 g f.w 0.40 g/100 g f.w Mean: **0.48** g	Biesiekierski et al 2011 (28) Food Standards Australia & New Zealand (55)
Almonds	0 g/100 g f.w 0 g/100 g f.w 0.2 g/100 g f.w Mean: **0.07** g	Biesiekierski et al 2011 (28) Food Standards Australia & New Zealand (55) Varo et al 1984 (106)
Anchovy	**0** g	Norwegian food database (50)
Apple	2.40 g/100 g f.w 6.05 g/100 g f.w 1.63 g/100 g f.w 3.77 g/100 g f.w 4.40 g/100 g f.w 2.45 g/100 g f.w 7.64 g/100 g f.w 2.65 g/100 g f.w Mean: **3.87** g	Varo et al 1984 (105) Wrolstad et al 1981 (108) Jovanovich-Malinovska et al 2014 (87) Li et al 2002 (92) Food Standards Australia & New Zealand (55) Aprea et al 2017 (70) Ma et al 2014 (93) Chareoansiri et al 2009 (75)
Apple, dried	24.9 g/100 g f.w 23.1 g/100 g f.w Mean: 24.0 g	Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Apricot, dried	**0** g	Stacewicz-Sapuntzakis et al 2001 (103), Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Avocado	0 g/100 g f.w 0 g/100 g f.w 0.04 g/ 100 g f.w Mean: **0.01** g	Muir et al 2009 (99) Food Standards Australia & New Zealand (55) Li et al 2002 (92)
Bacon	**0** g	Fineli: Finnish food database (54)
Bamboo shoots	**0** g	Food Standards Australia & New Zealand (55)
Banana	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.20 g/100 g f.w 0 g/100 g f.w 0.55 g/100 g f.w 0 g/100 g f.w 1.20 g/100 g f.w Mean: **0.24** g	Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Varo et al 1984 (105) Judprasong et al 2011 (88) Shalini et al 2015 (101) Li et al 2002 (92) Food Standards Australia & New Zealand (55) Chareoansiri et al 2009 (75)
Barley	0 g/100 g d.w 0 g/100 f.w 0.006 g/100 g Mean: **0.002** g	Ispiryan et al 2020 (86) Varo et al 1984 (106) Henry et al 1989 (82)
Basil, dried	**0** g	Fineli: Finnish food database (54)
Basil, fresh	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Beer, alcohol free	**0** g	Fineli: Finnish food database (54)
Beer, lager	**0** g	Fineli: Finnish food database (54)
Beer, light	**0** g	Fineli: Finnish food database (54)
Bell pepper (green, yellow, red)	0 g/100 g f.w 0 g/100 g f.w	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)

	0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w 0.20 g/100 g f.w 0.33 g/100 g f.w Mean: **0.08** g	Martin-Villa et al 1982 (95) Varo et al 1984 (105) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54) Li et al 2002 (92)
Blueberry	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.40 g/100 g f.w 0.13 g/100 g f.w Mean: **0.11** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Food Standards Australia & New Zealand (55) Mikulic-Petkovsek et al 2012 (96)
Bread, white (loff)	0.16 g/100 g f.w 0.19 g/100 g d.w 0.30 g/100 g f.w 0.10 g/100 g f.w Mean: **0.19** g	Biesiekierski et al 2011 (28) Ispiryan et al 2020 (86) Food Standards Australia & New Zealand (55) Varo et al 1984 (106)
Bread, wholegrain	0.11 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.04** g	Biesiekierski et al 2011 (28) Food Standards Australia & New Zealand (55) Varo et al 1984 (106)
Broccoli	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.20 g/100 g f.w Mean: **0.05** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99) Martin-Villa et al 1982 (95) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Brussels sprouts	**0** g	Jovanovich-Malinovska et al 2014 (87), Muir et al 2009 (99), Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Cabbage	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.33 g/100 g f.w 0.54 g/100 g f.w Mean: **0.11** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Food Standards Australia & New Zealand (55) Martin-Villa et al 1982 (95) Varo et al 1984 (105) Shanmugavelan et al 2013 (102) Li et al 2002 (92)
Cabbage, Chinese	**0** g	Varo et al 1984 (105) & Food Standards Australia & New Zealand (55)
Candy, hard	**0.98** g/100 g f.w	Koh et al 2018 (91)
Candy, mix	**0.75** g/100 g f.w	Koh et al 2018 (91)
Carrot	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.11 g/100 g f.w 0.48 g/100 g f.w 0.87 g/100 g f.w Mean: **0.24** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99) Food Standards Australia & New Zealand (55) Li et al 2002 (92) Judprasong et al 2011 (88) Shanmugavelan et al 2013 (102)
Cashews, salted	0 g/100 g f.w 0 g/100 g f.w 0.005 g/100 g f.w Mean: **0.002** g	Fineli: Finnish food database (54) Food Standards Australia & New Zealand (55) Griffin et al 2017 (80)

Cauliflower	**0** g	Jovanovich-Malinovska et al 2014 (87)
Caviar	**0** g	Fineli: Finnish food database (54)
Cheese, Brie	**0** g	Norwegian food database (50), Food Standards Australia & New Zealand (55)
Cheese, Cottage	**0** g	Norwegian food database (50), Food Standards Australia & New Zealand (55)
Cheese, Cream	**0** g	Fineli: Finnish food database (54)
Cheese, Cream light	**0** g	Fineli: Finnish food database (54)
Cheese, mature	**0** g	Norwegian food database (50), Food Standards Australia & New Zealand (55)
Cheese, mature, Norvegia	**0** g	Norwegian food database (50)
Cheese, Whey	**0** g	Norwegian food database (50)
Cheese, Whey, Gulbrandsdalsost	**0** g	Norwegian food database (50)
Cherries	**0** g	Jovanovich-Malinovska et al 2014 (87), Wrolstad et al 1981 (108), Food Standards Australia & New Zealand (55), Chareoansiri et al 2009 (75) & Fineli: Finnish food database (54)
Chicken, breast	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, thighs	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, with skin	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chips, potato	0.24 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.08** g	Biesiekierski et al 2011 (28) Fineli: Finnish food database (54) Food Standards Australia & New Zealand (55)
Chives	**0.10** g/100 g f.w	Muir et al 2009 (99) & Varo et al 1984 (105)
Chocolate, confectionery	0 g/100 g f.w 0.58 g/100 g f.w Mean: **0.28** g	Fineli: Finnish food database (54) Food Standards Australia & New Zealand (55)
Chocolate, dark	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Chocolate, dark 70%	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Chocolate, milk	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Clementine	0 g/100 g f.w 0.40 g/100 g f.w Mean: **0.20** g	Food Standards Australia & New Zealand (55) Varo et al 1984 (105)
Cod, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cod, fillet, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cofee, boiled	**0** g	Fineli: Finnish food database (54)
Coffee, cappuccino	**0** g	Fineli: Finnish food database (54)
Coffee, coffee latte	**0** g	Fineli: Finnish food database (54)
Coffee, espresso	**0** g	Fineli: Finnish food database (54)
Coffee, filtered	**0** g	Fineli: Finnish food database (54)
Coffee, instant	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cordial, fun light	**0** g	Funlight.no/products/ (59)
Corn flakes	0 g/100 g f.w 0.1 g/100 g f.w	Biesiekierski et al 2011 (28) Food Standards Australia & New Zealand (55)

	0 g/100 g f.w Mean: 0.03	Varo et al 1984 (106)
Corn starch	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Corn, sweet	0 g/100 g f.w 0 g/100 g f.w 0.55 g/100 g f.w Mean: **0.18** g	Muir et al 2009 (99) Food Standards Australia & New Zealand (55) Li et al 2002 (92)
Cream, sour 10% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 20% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 35% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, whipping	**0** g	Fineli: Finnish food database (54)
Crisp bread, light	**0.1** g/100 g f.w	Biesiekierski et al 2011 (28)
Crisp bread, dark	**0.08** g/100 g f.w	Biesiekierski et al 2011 (28)
Crisp bread, wholegrain rye with yeast	0.01 g/100 g f.w 0.2 g/100 g f.w 0 g/100 g f.w Mean: **0.07** g	Biesiekierski et al 2011 (28) Varo et al 1984 (106) Food Standards Australia & New Zealand (55)
Cucumber	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.07 g/100 g f.w 0.15 g/100 g f.w Mean: **0.04** g	Muir et al 2009 (99) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54) Martin-Villa et al 1982 (95) Li et al 2002 (92)
Currant, black	0 g/100 g f.w 0.50 g/100 g f.w 0.56 g/100 g f.w Mean: **0.35** g	Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Mikulic-Petkovsek et al 2012 (96)
Currant, red	0 g/100 g f.w 1.50 g/100 g f.w 0.40 g/100 g f.w Mean: **0.63** g	Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Mikulic-Petkovsek et al 2012 (96)
Drink, alcoholic	**0** g	Norwegian food database (50)
Durumwheat/Semolina	**0** g	Ispiryan et al 2020 (86) & Ziegler et al 2016 (110)
Egg noodles	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Egg, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Elderberry	**0.17** g/100 g f.w	Mikulic-Petkovsek et al 2012 (96)
Energy drink, battery	**0** g	Fineli: Finnish food database (54)
Fish, balls	0 g	Norwegian food database (50)
Grain mix (barley, wheat, oat & rye)	**0** g	Food Standards Australia & New Zealand (55)
Flour, rye	**0** g/100 g f.w	Varo et al 1984 (106) & Henry et al 1986 (82)
Flour, wheat, white	0.06 g/100 g f.w 0 g/100 g d.w 0 g/100 g d.w Mean: **0.01** g	Varo et al 1984 (106) Ispiryan et al 2020 (86) Ziegler et al 2016 (110)
Flour, wheat, wholemeal	**0** g	Ziegler et al 2016 (110) & Ispiryan et al 2020 (86)
Garlic	0 g/100 g f.w 0 g/100 g f.w 0.04 g/100 g f.w	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Judprasong et al 2011 (88)

	0.20 g/100 g f.w Mean: **0.06** g	Fineli: Finnish food database (54)
Grapes	0.71 g/100 g f.w 0.33 g/100 g f.w 1.83 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.32** g	Li et al 2002 (92) Food Standards Australia & New Zealand (55) Shanmugavelan et al 2013 (102) Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Varo et al 1984 (105) Wrolstad et al 1981 (108) Jovanovich-Malinovska et al 2014 (87) Chareoansiri et al 2009 (75)
Ham, cooked	**0** g	Norwegian food database (50)
Hazelnuts	0 g/100 g f.w 0.10 g/100 g f.w Mean: **0.05** g	Food Standards Australia & New Zealand (55) & Varo et al 1984 (106)
Herring, raw	**0** g	Fineli: Finnish food database (54)
Honey	7.12 g/100 g f.w 10.6 g/100 g f.w 6.30 g/100 g f.w 10.1 g/100 g f.w Mean: **6.82** g	de la Fuente et al 2011 (78) Food Standards Australia & New Zealand (55) Bogdanov et al 2008 (71) Dominiguez et al 2016 (79)
Ice cream, vanilla	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Jalapeno	**0** g	Fineli: Finnish food database (54)
Juice, apple	3.67 g/100 g f.w 0.70 g/100 g f.w 1.90 g/100 g f.w 3.00 g/100 g f.w 3.00 g/100 g f.w Mean: **2.04** g	Wrolstad et al 1981 (108) Food Standards Australia & New Zealand (55) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54) Chinnici et al 2005 (76)
Juice, grape	**0.10** g	Fineli: Finnish food database (54)
Juice, orange	0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w 0.20 g/100 g f.w 0.22 g/100 g f.w Mean: **0.09** g	Li et al 2002 (92) Food Standards Australia & New Zealand (55) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54) Vidal-Valverde et al 1985 (107)
Ketchup	**1.8** g/100 g f.w	Varo et al 1984 (105)
Kiwi fruit	0 g g/100 g f.w 0.50 g/100 g f.w 1.07 g/100 g f.w Mean: **0.50** g	Muir et al 2009 (99) Food Standards Australia & New Zealand (55) Shanmugavelan et al 2013 (102)
Leek	0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w 0.22 g/100 g f.w Mean: **0.08** g	Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Martin-Villa et al 1982 (95) Judprasong et al 2011 (88)
Lettuce	0 g/100 g f.w 0 g/100 g f.w 0.09 g/100 g f.w	Chumpiatzi et al 2018 (77) Muir et al 2009 (99) Hernandez-Hernandez et al 2011 (83)

	0.10 g/100 g f.w 0.11 g/100 g f.w 0.12 g/100 g f.w 0.24 g/100 g f.w 0.84 g/100 g f.w Mean: **0.16** g	Varo et al 1984 (105) Martin-Villa et al 1982 (95) Jovanovich-Malinovska et al 2014 (87) Judprasong et al 2011 (88) Shanmugavelan et al 2013 (102)
Lingonberry	**0** g	Mikulic-Petkovsek et al 2012 (96)
Linseed	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Mackerel, raw	**0** g	Norwegian food database (50)
Margarine/butter	**0** g	Fineli: Finnish food database (54)
Mayonnaise, original	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Meat, beef, fillet	**0** g	Norwegian food database (50)
Meat, pork, chop	**0** g	Norwegian food database (50)
Melon, honeydew	0 g/100 g f.w 0 g/100 g f.w 0.4 g/100 g f.w Mean: **0.13** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Food Standards Australia & New Zealand (55)
Milk, chocolate	**0** g	Food Standards Australia & New Zealand (55)
Milk, full-fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, powder	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Milk, semi skimmed	**0** g	Food Standards Australia & New Zealand (55)
Milk, semi skimmed 0,5%fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, skimmed	**0** g	Food Standards Australia & New Zealand (55)
Muesli with fruit	0 g/100 g f.w 0.7 g/100 g f.w Mean: **0.35** g	Biesiekierski et al 2011 (28) Food Standards Australia & New Zealand (55)
Mustard	**0** g	Chumpiatzi et al 2018 (77) & Varo et al 1984 (105)
Nectarine	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.37 g/100 g f.w Mean: **0.12** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Food Standards Australia & New Zealand (55) Li et al 2002 (92)
Oat	**0** g	Ispiryan et al 2020 (86), Biesiekierski et al 2011 (28), Henry et al 1989 (82) & Varo et al 1984 (106)
Onion powder	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Onion, raw	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.79 g/100 g f.w Mean: **0.10** g	Muir et al 2009 (99) Judprasong et al 2011 (88) Hernandez-Hernandez et al 2011 (83) Martin-Villa et al 1982 (95) Li et al 2002 (92) Food Standards Australia & New Zealand (55) Shanmugavelan et al 2013 (102) Jovanovich-Malinovska et al 2014 (87)
Orange	0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w 0.15 g/100 g f.w 0.20 g/100 g f.w 1.55 g/100 g f.w	Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Varo et al 1984 (105) Li et al 2002 (92) Food Standards Australia & New Zealand (55) Chareoansiri et al 2009 (75)

	Mean: **0.33** g	
Parsley	**0** g	Varo et al 1984 (105)
Pastille, artificially sweetened	**0** g	Fineli: Finnish food database (54)
Peanuts, salted	**0** g	Food Standards Australia & New Zealand (55)
Pear	3.63 g/100 g f.w 2.30 g/100 g f.w 1.10 g/100 g f.w 4.93 g/100 g f.w 5.00 g/100 g f.w Mean: **3.92** g	Muir et al 2009 (99) Varo et al 1984 (105) Li et al 2002 (92) Wrolstad et al 1981 (108) Food Standards Australia & New Zealand (55)
Peas	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w Mean: **0.02** g	Fineli: Finnish food database (54) Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Food Standards Australia & New Zealand (55)
Pine nuts	**0** g	Food Standards Australia & New Zealand (55) & Ruiz-Aceituno et al 2012 (100)
Pineapple	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.25 g/100 g f.w 0.50 g/100 g f.w Mean: **0.15** g	Chumpiatzi et al 2018 (77) Muir et al 2009 (99) Fineli: Finnish food database (54) Li et al 2002 (92) Food Standards Australia & New Zealand (55)
Plum	**0** g	Jovanovich-Malinovska et al 2014 (87), Varo et al 1984 (105), Li et al 2002 (92), Wrolstad et al 1981 (108), Stacewicz - Sapuntzakis et al 2001 (103), & Food Standards Australia & New Zealand (55)
Potato flour/starch	**0** g	Ispiryan et al 2020 (86), Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Potato, boiled	**0** g	Judprasong et al 2011 (88), Muir et al 2009 (99), Varo et al 1984 (105), Li et al 2002 (92)
Potato, French fries	0 g/100 g f.w 0 g/100 g f.w 0.06 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w Mean: **0.01** g	Judprasong et al 2011 (88) Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Varo et al 1984 (105) Li et al 2002 (92)
Potato, fried	**Same as boiled**	
Prunes	0 0 0 0.20 Mean: **0.05** g	Stacewicz-Sapuntzakis et al 2001 (103) Li et al 2002 (92) Food Standards Australia & New Zealand (55) Varo et al 1984 (105)
Pudding, almond	**0** g	Fineli: Finnish food database (54)
Pulses, dry	**0** g	Biesiekierski et al 2011 (28), Hernandez-Hernandez 2011 (83) & Food Standards Australia & New Zealand (55)
Pumpkin	0 g/100 g f.w 0 g/100 g f.w 0.78 g/100 g f.w Mean: **0.26** g	Jovanovich-Malinovska et al 2014 (87) Fineli: Finnish food database (54) Judprasong et al 2011 (88)
Raisins	0 g/100 g f.w 0 g/100 g f.w	Varo et al 1984 (105) Stacewicz-Sapuntzakis et al 2001 (103)

	1.79 g/100 g f.w 3.00 g/100 g f.w Mean: **1.20** g	Li et al 2002 (92) Food Standards Australia & New Zealand (55)
Raspberry	0 g/100 g f.w 0 g/100 g f.w 0.60 g/100 g f.w 0.60 g/100 g f.w 0.60 g/100 g f.w 0.79 g/100 g f.w 0.12 g/100 g f.w 0.22 g/100 g f.w Mean: **0.39** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Varo et al 1984 (105) Food Standards Australia & New Zealand (55) Milivojevic et al 2011 (97) Cekic et al 2009 (74) Wrolstad et al 1981 (108) Mikulic-Petkovsek et al 2012 (96)
Rice, boiled	**0** g	Biesiekierski et al 2011 (28), Li et al 2002 (92), Varo et al 1984 & Chumpiatzi et al 2018 (77)
Rye	**0** g	Ispiryan et al 2020 (86) & Varo et al 1984 (106)
Salmon, smoked and cured	**0** g	Norwegian food database (50)
Salmon/Trout, raw	**0** g	Norwegian food database (50)
Sauce, soya	**0** g	Food Standards Australia & New Zealand (55)
Sauce, vanilla	**0** g	Fineli: Finnish food database (54)
Shellfish, boiled	**0** g	Norwegian food database (50)
Soda, light	**0** g	Fineli: Finnish food database (54)& Norwegian food database (50)
Soda, original	**0** g	Fineli: Finnish food database (54), Norwegian food database (50) & Vidal-Valverde et al 1985 (107)
Spaghetti, boiled	**0** g	Biesiekierski et al 2011 (28), Ispiryan et al 2020 (86), Varo et al 1984 (106) & Li et al 2002 (92)
Spinach	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.49 g/100 g f.w Mean: **0.12** g	Muir et al 2009 (99) Varo et al 1984 (105) Hernandez-Hernandez et al 2011 (83) Martin-Villa et al 1982 (95) Li et al 2002 (92)
Spread, mackerel in tomato	**0** g	Norwegian food database (50) (estimated using ingredients)
Spread, peanut butter	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Spread, salmon in box	**0** g	Norwegian food database (50)
Steak, deer	**0** g	Norwegian food database (50)
Steak, pork	**0** g	Norwegian food database (50)
Strawberry	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.30 g/100 g f.w 0.40 g/100 g f.w 0.30 g/100 g f.w 0.23 g/100 g f.w Mean: **0.15** g	Jovanovich-Malinovska et al 2014 (87) Chumpiatzi et al 2018 (77) Varo et al 1984 (105) Wrolstad et al 1981 (108) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54) Chareoansiri et al 2009 (75) Mikulic-Petkovsek et al 2012 (96)
Sugar, icing	**0** g	Food Standards Australia & New Zealand (55)
Sugar, white	**0** g	Food Standards Australia & New Zealand (55)
Sunflower seeds	**0** g/100 g f.w	Biesiekierski et al 2011 (28), Food Standards Australia & New Zealand (55) & Judprasong et al 2011 (88)
Sweetener, natreen	**0** g	https://www.natreen.no/produkter/natreen-original/sotningstabletter/ (60)

Tea, black	**0** g	Norwegian food database (50)
Tea, green	**0** g	Norwegian food database (50)
Tea, herbal	**0** g	Fineli: Finnish food database (54)
Tomatoes	0 g/100 g f.w 0 g/100 g f.w 0.10 g/100 g f.w 0.30 g/100 g f.w 0.70 g/100 g f.w 0.70 g/100 g f.w 0.70 g/100 g f.w Mean: **0.36** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87) Martin-Villa et al 1982 (95) Food Standards Australia & New Zealand (55) Varo et al 1984 (105) Li et al 2002 (92) Fineli: Finnish food database (54)
Tuna, canned	**0** g	Norwegian food database (50)
Turnip	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.70 g/100 g f.w Mean: **0.14** g	Muir et al 2009 (99) Martin-Villa et al 1982 (95) Varo et al 1984 (105) Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Walnuts	**0** g	Food Standards Australia & New Zealand (55)
Water, mineral	**0** g	Norwegian food database (50)
Water, tap	**0** g	Norwegian food database (50)
Wheat	**0** g	Henry et al 1989 (82)
Wheat, bran	**0** g	Ispiryan et al 2020 (86) & Varo et al 1984 (106)
Wine, fortified	**0** g	Fineli: Finnish food database (54)
Wine, liquor	**0** g	Norwegian food database (50)
Wine, red	**0** g	Fineli: Finnish food database (54)
Wine, white	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, drink flavored	**0** g	Fineli: Finnish food database (54)
Yoghurt, fruit	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, fruit, light	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, plain	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, Skyr (blueberry)	**0** g	Fineli: Finnish food database (54)
Yoghurt, Skyr w/taste	**0** g	Fineli: Finnish food database (54)

*Reported as a mix of almonds, sunflower seeds and linseed, f.w: fresh weight, d.w: dry weight, excess fructose= fructose-glucose.

Lactose		
Food	**Value**	**Reference**
Alcopop	**0** g	Fineli: Finnish food database (54)
All Bran cereal	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Almonds	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Anchovy	**0** g	Norwegian food database (50)
Apple	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Apple, dried	**0** g	Food Standards Australia & New Zealand (55)
Apricot, dried	**0** g	Food Standards Australia & New Zealand (55)
Avocado	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Bacon	**0** g	Fineli: Finnish food database (54)
Bamboo shoots	**0** g	Food Standards Australia & New Zealand (55)
Banana	**0** g	Food Standards Australia & New Zealand (55) & Chumpiatzi et al 2018 (77)
Barley	**0** g	Ispiryan et al 2020 (86)

Basil, dried	**0** g	Fineli: Finnish food database (54)
Basil, fresh	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Beer, alcohol free	**0** g	Fineli: Finnish food database (54)
Beer, lager	**0** g	Fineli: Finnish food database (54)
Beer, light	**0** g	Fineli: Finnish food database (54)
Bell pepper (green, yellow, red)	**0** g	Food Standards Australia & New Zealand (55)
Blueberry	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Bread, Kneipp	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Bread, white (loff)	**0** g	Ispiryan et al 2020 (86)
Bread, wholegrain	**0** g	Biesiekierski et al 2011 (28)
Broccoli	**0** g	Fineli: Finnish food database (54)
Brussels sprouts	**0** g	Food Standards Australia & New Zealand (55)
Cabbage	**0** g	Fineli: Finnish food database (54)
Cabbage, Chinese	**0** g	Food Standards Australia & New Zealand (55)
Candy, hard	**4.67** g/100 g f.w	Koh et al 2018 (91)
Candy, mix	**2.33** g/100 g f.w	Koh et al 2018 (91)
Carrot	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cashews, salted	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cauliflower	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Caviar	**0** g	Fineli: Finnish food database (54)
Cheese, Brie	**0** g	Norwegian food database (50) & Food Standards Australia & New Zealand (55)
Cheese, Cottage	**1.5** g/100 g f.w	Norwegian food database (50)
Cheese, Cream	**4.30** g/100 g f.w	Philadelphia.no (57)
Cheese, Cream light	**5.20** g/100 g f.w	Philadelphia.no (57)
Cheese, mature	**0** g	Norwegian food database (50)
Cheese, mature, Norvegia	**0** g	Norwegian food database (50)
Cheese, Whey	**39.8** g/100 g f.w	Norwegian food database (50)
Cheese, Whey, Gulbrandsdalsost	**42.0** g/100 g f.w	Norwegian food database (50)
Cherries	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Chicken, breast	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, thighs	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, with skin	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chips, potato	**0** g	Biesiekierski et al 2011 (28), Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Chives	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Chocolate, confectionery	7.80 g/100 g f.w 7.93 g/100 g f.w Mean: **7.86** g	Fineli: Finnish food database (54) Food Standards Australia & New Zealand (55)
Chocolate, dark	0.40 g/100 g f.w 0.79 g/100 g f.w Mean: **0.59** g	Fineli: Finnish food database (54) Koh et al 2018 (91)

Chocolate, dark 70%	0.40 g/100 g f.w 0 g/100 g f.w Mean: **0.20** g	Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Chocolate, milk	11.6 g/100 g f.w 15.9 g/100 g f.w Mean: **13.7** g	Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Cinnamon	**0** g	Fineli: Finnish food database (54)
Clementine	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cod, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cod, fillet, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cofee, boiled	**0** g	Fineli: Finnish food database (54)
Coffee, cappuccino	**3.46** g/ 100 g f.w	Norwegian food database (50)
Coffee, coffee latte	**3.96** g/100 g f.w	Norwegian food database (50)
Coffee, espresso	**0** g	Fineli: Finnish food database (54)
Coffee, filtered	**0** g	Fineli: Finnish food database (54)
Coffee, instant	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cordial, fun light	**0** g	Funlight.no/products/ (59)
Corn flakes	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Corn starch	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Corn, sweet	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cream, sour 10% fat	**2.90** g/100 g f.w	Norwegian food database (50)
Cream, sour 20% fat	**3.70** g/100 g f.w	Norwegian food database (50)
Cream, sour 35% fat	**4.20** g/100 g f.w	Norwegian food database (50)
Cream, whipping	3.00 g/100 g f.w 2.90 g/100 g f.w Mean: **2.95** g	Norwegian food database (50) Fineli: Finnish food database (54)
Crisp bread, light	**0** g	Biesiekierski et al 2011 (28)
Crisp bread, dark	**0** g	Biesiekierski et al 2011 (28)
Crisp bread, wholegrain rye with yeast	**0** g	Food Standards Australia & New Zealand (55)
Cucumber	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Currant, black	**0** g	Food Standards Australia & New Zealand (55)
Currant, red	**0** g	Food Standards Australia & New Zealand (55)
Drink, alcoholic	**0** g	Norwegian food database (50)
Durumwheat/Semolina	**0** g	Ispiryan et al 2020 (86)
Egg noodles	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Egg, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Energy drink, battery	**0** g	Fineli: Finnish food database (54) & Ringnes.no (56)
Fish, balls	**0** g	Norwegian food database (50)
Grain mix (barley, wheat, oat & rye)	**0** g	Food Standards Australia & New Zealand (55)
Flour, rye	**0** g	Food Standards Australia & New Zealand (55)
Flour, wheat, white	**0** g	Ispiryan et al 2020 (86)
Flour, wheat, wholemeal	**0** g	Ispiryan et al 2020 (86)
Garlic	**0** g	Fineli: Finnish food database (54)

Grapes	**0** g	Chumpiatzi et al 2018 (77), Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Ham, cooked	**0** g	Norwegian food database (50)
Hazelnuts	**0 g**	Food Standards Australia & New Zealand (55)
Herring, raw	**0** g	Fineli: Finnish food database (54)
Honey	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Ice cream, vanilla	3.20 g/100 g f.w 5.60 g/100 g f.w Mean: **4.40** g	Food Standards Australia & New Zealand (55) Fineli: Finnish food database (54)
Jalapeno	**0** g	Fineli: Finnish food database (54)
Juice, apple	**0** g	Fineli: Finnish food database (54)
Juice, grape	**0** g	Fineli: Finnish food database (54)
Juice, orange	**0** g	Fineli: Finnish food database (54)
Kiwi fruit	**0** g	Food Standards Australia & New Zealand (55)
Leek	**0** g	Fineli: Finnish food database (54)
Lettuce	**0** g	Fineli: Finnish food database (54)
Linseed	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Mackerel, raw	**0** g	Norwegian food database (50)
Margarine/butter	**0.30** g/100 g f.w	Norwegian food database (50)
Mayonnaise, original	**0** g	Food Standards Australia & New Zealand (55) & Chumpiatzi et al 2018 (77)
Meat, beef, fillet	**0** g	Norwegian food database (50)
Meat, pork, chop	**0** g	Norwegian food database (50)
Melon, honeydew	**0** g	Food Standards Australia & New Zealand (55)
Milk, chocolate	**4.50** g	Norwegian food database (50)
Milk, full-fat	**4.50** g	Norwegian food database (50)
Milk, powder	50.9 g/100 g f.w 56.0 g/100 g f.w Mean: **55.4** g	Fineli: Finnish food database (54) Food Standards Australia & New Zealand (55)
Milk, semi skimmed	**4.50** g/100 g f.w	Norwegian food database (50)
Milk, semi skimmed 0,5%fat	**4.50** g/100 g f.w	Norwegian food database (50)
Milk, skimmed	**4.50** g/100 g f.w	Norwegian food database (50)
Muesli with fruit	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Mustard	**0** g	Chumpiatzi et al 2018 (77)
Nectarine	**0** g	Food Standards Australia & New Zealand (55)
Oat	**0** g	Food Standards Australia & New Zealand (55) & Biesiekierski et al 2011 (28)
Onion powder	**0** g	Food Standards Australia & New Zealand (55)
Onion, raw	**0** g	Fineli: Finnish food database (54)
Orange	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Parsley	**0** g	Fineli: Finnish food database (54)
Pastille, artificially sweetened	**0** g	Fineli: Finnish food database (54)
Peanuts, salted	**0** g	Food Standards Australia & New Zealand (55)
Pear	**0** g	Food Standards Australia & New Zealand (55)
Peas	**0** g	Fineli: Finnish food database (54)
Pepper, black	**0** g	Food Standards Australia & New Zealand (55)
Pine nuts	**0** g	Food Standards Australia & New Zealand (55)
Pineapple	**0** g	Chumpiatzi et al 2018 (77) (77) & Food Standards Australia & New Zealand (55)
Plum	**0** g	Food Standards Australia & New Zealand (55)

Potato flour/starch	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Potato, boiled	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Potato, French fries	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Potato, fried	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Prunes	**0** g	Food Standards Australia & New Zealand (55)
Pudding, almond	4.30 g/100 g f.w 4.40 g/100 g f.w Mean: **4.35** g	Norwegian food database (50) Fineli: Finnish food database (54)
Pulses, dry	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Pumpkin	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Raisins	**0** g	Food Standards Australia & New Zealand (55)
Raspberry	**0** g	Food Standards Australia & New Zealand (55)
Rice, boiled	**0** g	Biesiekierski et al 2011 (28), Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Rye	**0** g	Ispiryan et al 2020 (86)
Salmon, smoked and cured	**0** g	Norwegian food database (50)
Salmon/Trout, raw	**0** g	Norwegian food database (50)
Sauce, soya	**0** g	Food Standards Australia & New Zealand (55)
Sauce, vanilla	3.20 g/100 g f.w 4.50 g/100 g f.w Mean: **3.85** g	Norwegian food database (50) Fineli: Finnish food database (54)
Shellfish, boiled	**0** g	Norwegian food database (50)
Soda, light	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Soda, original	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Spaghetti, boiled	**0** g	Biesiekierski et al 2011 (28) & Ispiryan et al 2020 (86)
Spinach	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Spread, mackerel in tomato	**0** g	Norwegian food database (50)
Spread, peanut butter	**0** g	Chumpiatzi et al 2018 (77) &Food Standards Australia & New Zealand (55)
Spread, salmon in box	**0** g	Norwegian food database (50)
Steak, deer	**0** g	Norwegian food database (50)
Steak, pork	**0** g	Norwegian food database (50)
Strawberry	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Sugar, icing	**0** g	Food Standards Australia & New Zealand (55)
Sugar, white	**0** g	Food Standards Australia & New Zealand (55)
Sunflower seeds	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Sweetener, natreen	**0** g	https://www.natreen.no/produkter/natreen-original/sotningstabletter/ (60)
Tea, black	**0** g	Norwegian food database (50)
Tea, green	**0** g	Norwegian food database (50)
Tea, herbal	**0** g	Fineli: Finnish food database (54)
Tomatoes	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Tuna, canned	**0** g	Norwegian food database (50)
Turnip	**0** g	Fineli: Finnish food database (54)

Walnuts	**0** g	Food Standards Australia & New Zealand (55)
Water, mineral	**0** g	Norwegian food database (50)
Water, tap	**0** g	Norwegian food database (50)
Wheat, bran	**0** g	Ispiryan et al 2020 (86)
Wine, fortified	**0** g	Fineli: Finnish food database (54)
Wine, liquor	**0** g	Norwegian food database (50)
Wine, red	**0** g	Fineli: Finnish food database (54)
Wine, white	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, drink flavored	**4.20** g/100 g f.w	Fineli: Finnish food database (54)
Yoghurt, fruit	**4.50** g/100 g f.w	Norwegian food database (50)
Yoghurt, fruit, light	**5.90** g/100 g f.w	Calculated from yoghurt with fruit: 89% yoghurt
Yoghurt, GO morgen light	**5.25** g/100 g f.w	Norwegian food database (50)
Yoghurt, plain	**5.60** g/100 g f.w	Norwegian food database (50)
Yoghurt, rislunsj w/strawberry	**3.80** g/100 g f.w	Norwegian food database (50)
Yoghurt, Skyr (blueberry)	**4.0**0 g/100 g f.w	Norwegian food database (50)
Yoghurt, Skyr w/taste	**4.0**0 g/100 g f.w	Norwegian food database (50)
Yoghurt, YT	**4.5**0 g/100 g f.w	Tine.no (61)

f.w: fresh weight, d.w: dry weight.

Polyols		
Food	**Value**	**Reference**
Alcopop	**0** g	Fineli: Finnish food database (54)
All Bran cereal	**0** g	Biesiekierski et al 2011 (28)
Almonds	**0** g	Biesiekierski et al 2011 (28), Yao et al 2014 (109) & Fineli: Finnish food database (54)
Anchovy	**0** g	Norwegian food database (50)
Apple	0.76 g/100 g f.w 0.41 g/100 g f.w 0.68 g/100 g f.w 0.43 g/100 g f.w 0.55 g/100 g f.w 1.79 g/100 g f.w Mean: **0.77** g	Muir et al 2009 (99) Wrolstad et al 1981 (108) Jovanovich-Malinovska et al 2014 (87) Food Standards Australia & New Zealand (55) Aprea et al 2017 (70) Ma et al 2014 (93)
Apple, dried	**1.90** g/100 g f.w	Yao et al 2014 (109)
Apricot, dried	4.40 g/100 g f.w 6.00 g/100 g f.w Mean: **5.20** g	Stacewicz-Sapuntzakis et al 2001 (103) Yao et al 2014 (109)
Avocado	**0.65** g/100 g f.w	Muir et al 2009 (99)
Bacon	**0** g	Fineli: Finnish food database (54)
Bamboo shoots	**0** g	Food Standards Australia & New Zealand (55)
Banana	**0** g	Food Standards Australia & New Zealand (55) & Chumpiatzi et al 2018 (77)
Barley	**0** g	Ispiryan et al 2020 (86)
Basil, dried	**0** g	Food Standards Australia & New Zealand (55)
Basil, fresh	**0** g	Food Standards Australia & New Zealand (55)
Beer, alcohol free	**0** g	Yao et al 2014 (109)
Beer, lager	**0** g	Yao et al 2014 (109)
Beer, light	**0** g	Yao et al 2014 (109)
Bell pepper (green, yellow, red)	0.19 g/100 g f.w 0 g/100 g f.w Mean: **0.09** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Blueberry	0 g/100 g f.w	Muir et al 2009 (99)

	0.96 g/100 g f.w 0.02 g/100 g f.w Mean: **0.33** g	Jovanovich-Malinovska et al 2014 (87) Makinen et al 1980 (94)
Bread, Kneipp	**0** g	Food Standards Australia & New Zealand (55)
Bread, white (loff)	**0** g	Ispiryan et al 2020 (86)
Bread, wholegrain	**0** g	Food Standards Australia & New Zealand (55)
Broccoli	0.20 g/100 g f.w 0.40 g/100 g f.w Mean: **0.30** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Brussels sprouts	0.20 g/100 g f.w 0.19 g/100 g f.w Mean: **0.19** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Cabbage	0.14 g/100 g f.w 0.18 g/100 g f.w Mean: **0.16** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Candy, hard	**20.5** g/100 g f.w	Koh et al 2018 (91)
Candy, mix	**21.3** g/100 g f.w	Koh et al 2018 (91)
Carrot	0.08 g/100 g f.w 0 g/100 g f.w Mean: **0.04** g	Jovanovich-Malinovska et al 2014 (87) Muir et al 2009 (99)
Cashews, salted	**0 g**	Food Standards Australia & New Zealand (55)
Cauliflower	2.96 g/100 g f.w 2.24 g/100 g f.w Mean: **2.60** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Caviar	**0** g	Fineli: Finnish food database (54)
Cheese, Brie	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Cottage	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Cream	**0** g	Fineli: Finnish food database (54)
Cheese, Cream light	**0** g	Fineli: Finnish food database (54)
Cheese, mature	**0** g	Food Standards Australia & New Zealand (55)
Cheese, mature, Norvegia	**0** g	Food Standards Australia & New Zealand (55)
Cheese, Whey	**0** g	Norwegian food database (50)
Cheese, Whey, Gulbrandsdalsost	**0** g	Norwegian food database (50)
Cherries	1.40 g/100 g f.w 0.24 g/100 g f.w 0.70 g/100 g f.w 2.00 g/100 g f.w 1.91 g/100 g f.w Mean: **1.25** g	Wrolstad et al 1981 (108) Jovanovich-Malinovska et al 2014 (87) Yao et al 2014 (109) Food Standards Australia & New Zealand (55) Ma et al 2014 (93)
Chicken, breast	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, thighs	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chicken, with skin	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Chips, potato	**0** g	Biesiekierski et al 2011 (28)
Chives	**0** g	Muir et al 2009 (99)
Chocolate, confectionery	**0** g	Food Standards Australia & New Zealand (55)
Chocolate, dark	**0.23** g/100 g f.w	Koh et al 2018 (91)

Chocolate, dark 70%	**0** g	Food Standards Australia & New Zealand (55)
Chocolate, milk	**0** g	Food Standards Australia & New Zealand (55)
Cinnamon	**0** g	Food Standards Australia & New Zealand (55)
Clementine	**0** g	Food Standards Australia & New Zealand (55)
Cloudberry	**0.02** g/100 g f.w	Makinen et al 1980 (94)
Cod, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cod, fillet, fried	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Cofee, boiled	**0** g	Fineli: Finnish food database (54)
Coffee, cappuccino	**0** g	Fineli: Finnish food database (54)
Coffee, coffee latte	**0** g	Fineli: Finnish food database (54)
Coffee, espresso	**0** g	Fineli: Finnish food database (54)
Coffee, filtered	**0** g	Fineli: Finnish food database (54)
Coffee, instant	**0** g	Fineli: Finnish food database (54) & Food Standards Australia & New Zealand (55)
Cordial, fun light	**0** g	Funlight.no/products/ (59)
Corn flakes	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Corn starch	**0** g	Food Standards Australia & New Zealand (55)
Corn, sweet	**0.45** g/100 g f.w	Muir et al 2009 (99)
Cream, sour 10% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 20% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, sour 35% fat	**0** g	Food Standards Australia & New Zealand (55)
Cream, whipping	**0** g	Fineli: Finnish food database (54)
Crisp bread, light	**0** g	Biesiekierski et al 2011 (28)
Crisp bread, dark	**0** g	Biesiekierski et al 2011 (28)
Crisp bread, wholegrain rye with yeast	**0** g	Food Standards Australia & New Zealand (55)
Cucumber	**0** g	Muir et al 2009 (99)
Currant, black	**1.34** g/100 g f.w	Jovanovich-Malinovska et al 2014 (87)
Currant, red	0 g/100 g f.w 0.02 g/100 g f.w Mean: **0.01** g	Jovanovich-Malinovska et al 2014 (87) Makinen et al 1980 (94)
Curry	**0** g	Food Standards Australia & New Zealand (55)
Drink, alcoholic	**0** g	Norwegian food database (50)
Durumwheat/Semolina	**0** g	Ispiryan et al 2020 (86)
Egg noodles	**0** g	Food Standards Australia & New Zealand (55)
Egg, boiled	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Energy drink, battery	**0** g	Fineli: Finnish food database (54) & Ringnes.no (56)
Fish, balls	**0** g	Norwegian food database (50)
Grain mix (barley, wheat, oat & rye)	**0** g	Food Standards Australia & New Zealand (55)
Flour, rye	**0** g	Food Standards Australia & New Zealand (55)
Flour, wheat, white	**0.01** g/100 g d.w	Ispiryan et al 2020 (86)
Flour, wheat, wholemeal	**0.05** g/100 g d.w	Ispiryan et al 2020 (86)
Garlic	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Grapes	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.20 g/100 g f.w Mean: **0.05** g	Muir et al 2009 (99) Chumpiatzi et al 2018 (77) Jovanovich-Malinovska et al 2014 (87) Wrolstad et al 1981 (108)
Ham, cooked	**0** g	Norwegian food database (50)
Hazelnuts	**0** g	Food Standards Australia & New Zealand (55)
Herring, raw	**0** g	Fineli: Finnish food database (54)

Honey	**0** g	Food Standards Australia & New Zealand (55)
Ice cream, vanilla	**0** g	Food Standards Australia & New Zealand (55)
Juice, apple	**0.50** g/100 g f.w	Yao et al 2014 (109)
Juice, orange	**0** g	Yao et al 2014 (109)
Kiwi fruit	**0** g	Muir et al 2009 (99)
Leek	**0** g	Jovanovich-Malinovska et al 2014 (87)
Lettuce	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.06 g/100 g f.w Mean: **0.01** g	Muir et al 2009 (99) Yao et al 2014 (109) Chumpiatzi et al 2018 (77) Jovanovich-Malinovska et al 2014 (87)
Lingonberry	**0.01** g/100 g f.w	Makinen et al 1980 (94)
Linseed	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Mackerel, raw	**0** g	Norwegian food database (50)
Margarine/butter	**0** g	Fineli: Finnish food database (54)
Mayonnaise, original	**0** g	Food Standards Australia & New Zealand (55) & Chumpiatzi et al 2018 (77)
Meat, beef, fillet	**0** g	Norwegian food database (50)
Meat, pork, chop	**0** g	Norwegian food database (50)
Melon, honeydew	0 g/100 g f.w 0.08 g/100 g f.w Mean: **0.04** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Milk, chocolate	**0** g	Food Standards Australia & New Zealand (55)
Milk, full-fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, powder	**0** g	Food Standards Australia & New Zealand (55) & Fineli: Finnish food database (54)
Milk, semi skimmed	**0** g	Food Standards Australia & New Zealand (55)
Milk, semi skimmed 0,5%fat	**0** g	Food Standards Australia & New Zealand (55)
Milk, skimmed	**0** g	Food Standards Australia & New Zealand (55)
Muesli with fruit	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)
Mustard	**0** g	Chumpiatzi et al 2018 (77)
Nectarine	1.01 g/100 g f.w 1.36 g/100 g f.w Mean: **1.18** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Oat	**0** g	Ispiryan et al 2020 (86) & Biesiekierski et al 2011 (28)
Onion, raw	**0** g	Muir et al 2009 (99)
Orange	**0** g	Muir et al 2009 (99) & Chumpiatzi et al 2018 (77)
Pastille, artificially sweetened	**93.2** g/100 g f.w	Fineli: Finnish food database (54)
Peanuts, salted	**0** g	Food Standards Australia & New Zealand (55) & Yao et al 2014 (109)
Pear	4.14 g/100 g f.w 2.16 g/100 g f.w 3.35 g/100 g f.w Mean: **3.22** g	Muir et al 2009 (99) Wrolstad et al 1981 (108) Food Standards Australia & New Zealand (55)
Peas	**0.56** g/100 g f.w	Jovanovich-Malinovska et al 2014 (87)
Pepper, black	**0** g	Food Standards Australia & New Zealand (55)
Pine nuts	**0** g	Food Standards Australia & New Zealand (55)
Pineapple	**0** g	Chumpiatzi et al 2018 (77) & Muir et al 2009 (99)
Plum	1.41 g/100 g f.w 5.40 g/100 g f.w 2.40 g/100 g f.w	Wrolstad et al 1981 (108) Stacewicz-Sapuntzakis et al 2001 (103) Yao et al 2014 (109)

	Mean: **3.07** g	
Potato flour/starch	**0** g	Ispiryan et al 2020 (86)
Potato, boiled	**0** g	Food Standards Australia & New Zealand (55) & Muir et al 2009 (99)
Potato, French fries	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Potato, fried	**0** g	Food Standards Australia & New Zealand (55) & Muir et al 2009 (99)
Prunes	14.7 g/100 g f.w 10.8 g/100 g f.w 11.4 g/100 g f.w Mean: **12.3** g	Stacewicz-Sapuntzakis et al 2001 (103) Yao et al 2014 (109) Food Standards Australia & New Zealand (55)
Pudding, almond	**0** g	Fineli: Finnish food database (54)
Pulses, dry	**0** g	Biesiekierski et al 2011 (28) & Yao et al 2014 (109)
Pumpkin	0.15 g/100 g f.w 0.40 g/100 g f.w Mean: **0.27** g	Jovanovich-Malinovska et al 2014 (87) Yao et al 2014 (109)
Raisins	**0** g	Stacewicz-Sapuntzakis et al 2001 (103)
Raspberry	0 g/100 g f.w 0.22 g/100 g f.w Mean: **0.11** g	Muir et al 2009 (99) Jovanovich-Malinovska et al 2014 (87)
Rice, boiled	**0** g	Biesiekierski et al 2011 (28), Food Standards Australia & New Zealand (55), Yao et al 2014 (109) & Chumpiatzi et al 2018 (77)
Rye	**0.01** g/100 g d.w	Ispiryan et al 2020 (86)
Salmon, smoked and cured	**0** g	Norwegian food database (50)
Salmon/Trout, raw	**0** g	Norwegian food database (50)
Sauce, soya	**0** g	Food Standards Australia & New Zealand (55)
Sauce, vanilla	**0** g	Fineli: Finnish food database (54)
Shellfish, boiled	**0** g	Norwegian food database (50)
Soda, light	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Soda, original	**0** g	Fineli: Finnish food database (54) & Norwegian food database (50)
Spaghetti, boiled	**0** g	Biesiekierski et al 2011 (28) & Ispiryan et al 2020 (86)
Spinach	**0** g	Muir et al 2009 (99)
Spread, mackerel in tomato	**0** g	Norwegian food database (50) (estimated using ingredients)
Spread, peanut butter	**0** g	Chumpiatzi et al 2018 (77) & Food Standards Australia & New Zealand (55)
Spread, salmon in box	**0** g	Norwegian food database (50)
Steak, deer	**0** g	Norwegian food database (50)
Steak, pork	**0** g	Norwegian food database (50)
Strawberry	0 g/100 g f.w 0 g/100 g f.w 0 g/100 g f.w 0.07 g/100 g f.w 0.34 g/100 g f.w Mean: **0.08** g	Muir et al 2009 (99) Wrolstad et al 1981 (108) Yao et al 2014 (109) Makinen et al 1980 (94) Jovanovich-Malinovska et al 2014 (87)
Sugar, icing	**0** g	Food Standards Australia & New Zealand (55)
Sugar, white	**0** g	Food Standards Australia & New Zealand (55)
Sunflower seeds	**0** g	Biesiekierski et al 2011 (28) & Food Standards Australia & New Zealand (55)

Sweetener, natreen	**0** g	https://www.natreen.no/produkter/natreen-original/sotningstabletter/ (60)
Tea, black	**0** g	Norwegian food database (50)
Tea, green	**0** g	Norwegian food database (50)
Tea, herbal	**0** g	Fineli: Finnish food database (54)
Tomatoes	**0** g	Muir et al 2009 (99) & Jovanovich-Malinovska et al 2014 (87)
Tuna, canned	**0** g	Norwegian food database (50)
Turnip	**0.22** g/100 g f.w	Muir et al 2009 (99)
Walnuts	**0** g	Food Standards Australia & New Zealand (55)
Water, mineral	**0** g	Norwegian food database (50)
Water, tap	**0** g	Norwegian food database (50)
Wheat, bran	**0.06** g/100 g d.w	Ispiryan et al 2020 (86)
Wine, fortified	**0** g	Fineli: Finnish food database (54)
Wine, liquor	**0** g	Norwegian food database (50)
Wine, red	**0** g	Yao et al 2014 (109)
Wine, white	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, drink flavored	**0** g	Fineli: Finnish food database (54)
Yoghurt, fruit	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, fruit, light	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, plain	**0** g	Food Standards Australia & New Zealand (55)
Yoghurt, Skyr (blueberry)	**0** g	Fineli: Finnish food database, ingredients (54)
Yoghurt, Skyr w/taste	**0** g	Skyr® | Et perfekt lite måltid (q-meieriene.no) (58)

f.w: fresh weight, d.w: dry weight.

Appendix IV: IBD diagnostic criteria according to Lennard-Jones et al.

Ulcerative colitis:

Clinical symptoms:

Diarrhea often with blood. Frequent bowel movements with small volumes, rectal urgency, colicky abdominal pain/ tenesmus, and incontinence. Patients with mainly distal disease may have constipation accompanied by frequent discharge of blood and mucus.

Diagnostic criteria (at least three out of the criteria present):

1. A history of diarrhea and/or pus in stools for more than 4weeks or repeated episodes.
2. Macroscopic appearance at endoscopy of continuous mucosal inflammation affecting the rectum in continuity with some or the entire colon.
3. Microscopic features on biopsy compatible with UC,
4. No suspicion of CD on small bowel X-ray, ileocolonoscopy or biopsy.

Crohn's disease:

Clinical symptoms:

Abdominal pain, weight loss and/or diarrhea. Crohn´s disease that involves the colon may have a similar clinical presentation to ulcerative colitis. However, features that are suggestive of Crohn´s disease include absence of gross bleeding, presence of perianal disease.

Diagnostic criteria (at least two of the criteria present):

1. History of abdominal pain, weight loss and/or diarrhea for more than three months.

2. Characteristic endoscopic findings of ulceration (aphthous lesions, snail track ulceration) or cobble stoning or radiological features of stricture or cobble stoning.

3. Histopathology consistent with Crohn's disease (epithelioid granuloma of Langerhans type or transmural discontinuous focal or patchy inflammation).

4. Fistula and/or abscess in relation to affected bowel segments.

Appendix V: Examples of questions used in collection of demographic information in the IBSEN III study

IBSEN III | IBSEN III [1.4]

Bakgrunnsinformasjon

Sivilstatus

Kryss av for det som passer for din sivilstatus?

#1

- Gift
- Samboer
- Enslig
- Skilt
- Enke/enkemann

Kryss av for høyeste fullførte utdannelse:

#5

- Grunnskole/folkeskole
- Videregående skole
- Universitet/høyskole (fullført minst 2 år)

Røyk og snus

Røyker du eller har du røykt tobakk? Hvilket år startet du å røyke?

#79

- Ja
- Nei

Startet du å røyke før du fikk tarmsykdommen?

#80

- Ja
- Nei

Hvis du har sluttet, hvilket år sluttet du å røyke?

Sluttet du å røyke før du fikk tarmsykdommen?

#81

- Ja
- Nei

Hvor mange sigaretter om dagen (gjennomsnitt) røyker/røykte du?

Appendix VI: Examples of questions used in collection of information about specific diets in the IBSEN III study

Kosthold

Har du det siste året (hele året eller deler av året) fulgt et spesielt kosthold (for eksempel vegetar, glutenfri, lavkarbo, lavFODMAP etc.) #86

( ) Ja ( ) Nei

Hvis ja, hvilket kosthold (flere svar mulig)?

#87

- [ ] Veganer
- [ ] Glutenfri
- [ ] Laktoseredusert/laktosefri
- [ ] Lavkarbo/høyfett
- [ ] LavFODMAP
- [ ] Annet

Antall måneder veganer

Antall måneder glutenfri

Antall måneder laktoseredusert/laktosefri

Antall måneder lavkarbo/høyfett

Pre og pro-biotica, reiseaktivitet

Med pre- og probiotika mener vi matvarer eller kosttilskudd som inneholder bakteriestammer (for eksempel melkesyrebakterier) eller andre innholdsstoffer som skal stimulere en gunstig bakterieflora i tarmen. Biola og Activia er eksempler på produkter som inneholder probiotika.

Har du i de siste 3 månedene brukt pre- og/eller probiotikaprodukter regelmessig? ( ) Ja ( ) Nei

#90

Hvis ja: Hvilke(t) produkt(er)

Appendix VII: Overview of some questions from the dietary FFQ used in the IBSEN III study

1. Hvor mye brød spiser du?

Legg sammen det du vanligvis spiser av brødprodukter til alle måltider i løpet av en dag. Mengden oppgis i antall skiver (1/2 rundstykke = 1 skive; 1 bagett = 4 skiver; 1 ciabatta = 2 skiver).

Brødskalaens fire kategorier har vi satt inn for å hjelpe deg å vurdere grovheten på brødproduktene du spiser.

0-25% sammalt mel/hele korn | 25-50% sammalt mel/hele korn | 50-75% sammalt mel/hele korn | 75-100% sammalt mel/hele korn

Antall skiver

	Aldri	Sjelden	1-2/uke	3-4/uke	0.5/dag	1-2/dag	3-4/dag	5-6/dag	7-8/dag	9-10/dag	1 12/
Fint brød (f.eks. loff, baguetter, fine rundstykker, ciabatta) *	○	○	○	○	○	○	○	○	○	○	○
Halvgrovt brød (f.eks. kneipp, grove rundstykker) *	○	○	○	○	○	○	○	○	○	○	○
Grovt brød *	○	○	○	○	○	○	○	○	○	○	○
Ekstra grovt brød (rugbrød e.l.) *	○	○	○	○	○	○	○	○	○	○	○
Fint knekkebrød *	○	○	○	○	○	○	○	○	○	○	○
Grovt knekkebrød *	○	○	○	○	○	○	○	○	○	○	○

Hvor ofte spiser du havregrøt? *

○ Aldri ○ Sjelden ○ 1-2/mnd ○ 3-4/mnd ○ 1-2/uke ○ 3-4/uke ○ 5-6/uke ○ 7-8/uke

○ ≥9/uke

Dette elementet vises dersom et av følgende alternativer er valgt på spørsmål «Hvor ofte spiser du havregrøt?»: Sjelden, 3-4/mnd, 1-2/mnd, ≥9/uke, 3-4/uke, 1-2/uke, 7-8/uke, 5-6/uke

Hvor stor porsjon spiser du? *

○ A  ○ B  ○ C  ○ D 

Dette elementet vises dersom et av følgende alternativer er valgt på spørsmål «Hvor ofte spiser du havregrøt?»: Sjelden, 3-4/mnd, 1-2/mnd, ≥9/uke, 3-4/uke, 1-2/uke, 7-8/uke, 5-6/uke

Hvor mange porsjoner spiser du til et måltid? *

Velg ...

Appendix VIII: FODMAP values for all food items used in the IBSEN III study FFQ

Food	Fructan g/100 g	GOS g/100 g	Excess fructose g/100 g	Lactose g/100 g	Polyols g/100 g	Total FODMAP g/100 g
Alcoholic beverage (drink)	0	0	0	0	0	0
Alcopop	0	0	0	0	0	0
All Bran cereal	2.35	1.32	0.48	0	0	4.15
Almonds	0.85	0.58	0.06	0		1.49
Anchovy	0	0	0	0	0	0
Apple	0.05	0	3.87	0	0.77	4.69
Apple juice	0.05		2.55	0	0.50	3.10
Avocado	0	0	0.01	0	0.65	0.66
Bacon	0	0	0	0	0	0
Banana	0.45	0	0.24	0	0	0.69
Battery. energy drink	0	0	0	0	0	0
Beef	0	0	0	0	0	0
Beer. alcohol free	0	0	0	0	0	0
Beer. lager	0	0	0	0	0	0
Beer. light	0	0	0	0	0	0
Bell pepper	0	0	0.08	0	0.10	0.18
Blueberry	0.31	0	0.11	0	0.33	0.75
Bread. >50% wholegrain	1.26	0.13	0	0	0.02	1.41
Bread. Kneipp	1.47	0.08	0.01	0	0.01	1.57
Bread. white	0.41	0.11	0.19	0	0	0.71
Bread. wholegrain	0.58	0.54	0.04	0	0	1.16

Breakfast cereal	0.47	0.23	4.86	0	0.38	5.94
Breakfast cereal. sweet	0.76	0.08	0.01	0	0.01	0.86
Brie cheese	0	0	0	0	0	0
Broccoli	0.79	0.12	0.05	0	0.3	1.26
Brown whey cheese	0	0	0	39.8	0	39.8
Brown whey cheese. Gudbrandsdalost	0	0	0	42.0	0	42.0
Brussels sprout	0.69	0	0	0	0.20	0.89
Bun. cinnamon	0.75	0.08	0.01	0	0.01	0.85
Buns. wheat	0.75	0.08	0.01	0.99	0.01	1.84
Cabbage	0.64	0	0.11	0	0.16	0.91
Cake. chocolate	0.31	0.03	0	0.52	0	0.86
Cake. layered	0.19	0.02	0.11	1.33	0.03	1.68
Cake. mold	0.42	0.04	0	0.69	0	1.15
Candy without chocolate	0	0	0.75	2.33	21.3	24.4
Cappuccino	0	0	0	3.46	0	3.46
Carrot	0.04	0	0.24	0	0.04	0.32
Cashew		2.38	0	0	0	2.38
Cauliflower	0	0	0	0	2.6	2.6
Caviar	0	0	0	0	0	0
Cereal. 4 grains	1.93	0.23	0	0	0.01	2.17
Cherries	0.32	0	0	0	1.25	1.57
Chicken and turkey. stew	0.01	0	0.04	0	0.09	0.14
Chicken. spread	0	0	0	0	0	0
Chicken. stew	0.52	0.02	0.02	0	0.01	0.57
Chicken. thighs	0	0	0	0	0	0
Chicken. without skin	0.22	0	0.08	0	0	0.3
Chiken. fried	0	0	0	0	0	0
Chocolate. confectionery			0.29	7.89	0	8.18

Chocolate. dark			0	0.6	0	0.6
Chocolate. dark (70%)			0	0.2	0	0.2
Chocolate. milk			0	13.8	0	13.8
Chocolate. spread (duo)	0	0	1	5.6	0	6.6
Clementine	0.01	0	0.2	0	0	0.21
Cloudberry	0.31	0	0.11	0	0.33	0.75
Cod fillet. fried	0	0	0	0	0	0
Cod. coated with breadcrumbs	0	0	0	0	0	0
Cod. cooked	0	0	0	0	0	0
Coffee latte (full fat milk)	0	0	0	3.96	0	3.96
Coffee. boiled	0	0	0	0	0	0
Coffee. filtered	0	0	0	0	0	0
Coffee. instant	0	0	0	0	0	0
Cookies	0.59	0.06	0.01	0	0	0.66
Cordial. artificially sweetened	0	0	0	0	0	0
Corn	0	0	0.18	0	0.45	0.63
Cornflakes	1.07	0	0.03	0	0	1.10
Cottage cheese	0	0	0	1.50	0	1.50
Cranberries					0.02	0.02
Cream cheese	0	0	0	4.30	0	4.30
Cream cheese (light)	0	0	0	5.20	0	5.20
Cream. 5% fat	0	0	0	4.60	0	4.60
Crisp bread. dark	0.55	0	0.08	0	0	0.63
Crisp bread. light	0.77	0	0.10	0	0	0.87
Cucumber	0	0	0.04	0	0	0.04
Cultured milk. Biola	0	0	0	10.40	0	10.4
Cultured milk. Cultura	0	0	0	4.40	0	4.40
Currant	0.35	0	0.63	0	0.01	0.99

Deer. steak	0	0	0	0	0	0
Egg	0	0	0	0	0	0
Espresso	0	0	0	0	0	0
Fish and vegetable stew	0.12	0.02	0.04	0	0.05	0.23
Fish pudding	0	0	0	1.96	0	1.96
Fishballs	0	0	0	0	0	0
French fries	0.09	0	0.01	0	0	0.10
Fruit salad	0.08	0	1.48	0	1.02	2.58
Fruit. conserved	0.04	0	0.46	0	0.5	1.00
Fruit. dried	1.38		24.0	0	1.9	27.3
Grape juice	0	0	0.10	0		0.10
Grapes	0.02	0	0.32	0	0.05	0.39
Gratinated potatoes (cream)	0	0	0	0.59	0	0.59
Ham. cooked	0	0	0	0	0	0
Hamburger bread	0.46	0.04	0	0	0	0.50
Hard candy	0	0	0.98	4.67	20.5	26.1
Hazelnuts			0.05	0	0	0.05
Herring	0	0	0	0	0	0
Honey	0.01	0	7.80	0	0	7.81
Ice cream	0	0	0	4.40	0	4.40
Ice tea. light	0	0	0	0	0	0
Ice tea. with sugar	0	0	0.05	0	0.01	0.06
Italian salad (light)	0.02	0	0.70	0	0.14	0.86
Jam. light	0.17	0	0.72	0	0.22	1.11
Jam. original	0.17	0	0.72	0	0.22	1.11
Kebab	0.11	0.02	0.08	0	0.02	0.23
Ketchup	0.05	0	0.36	0	0	0.41
Kiwi	0	0	0.52	0	0	0.52

Lamb and cabbage stew	0.32	0	0.06	0	0.08	0.46
Lettuce	0.26	0.01	0.17	0	0.02	0.46
Linseed	0.85	0.58	0	0	0	1.43
Liver pate. baked	0	0	0	0	0	0
Liver pate. light (9% fat)	0	0	0	0	0	0
Lozenge with sweetner	0	0	0	0	93.2	93.2
Mackerel	0	0	0	0	0	0
Mackerel in tomato. spread	0	0	0	0	0	0
Margarine/butter	0	0	0	0.3	0	0.3
Mayonnaise (light)	0	0	0	0	0	0
Mayonnaise salad	0.02	0	0.70	0	0.14	0.86
Meat cakes	0.03	0	0	0.05	0	0.08
Meat. burger	0	0	0	0	0	0
Melon. honeydew	0.21	0	0.13	0	0.04	0.38
Milk. chocolate	0	0	0	4.50	0	4.50
Milk. full fat (3.5%)	0	0	0	4.50	0	4.50
Milk. semi skimmed (0.5% fat)	0	0	0	4.60	0	4.60
Milk. semi skimmed (1% fat)	0	0	0	4.50	0	4.50
Milk. skimmed	0	0	0	4.50	0	4.50
Minced meat stew	1.17	0.03	0.08	0	0.08	1.36
Mineral water	0	0	0	0	0	0
Muffin	0.52	0.05	0.01	0.74	0	1.32
Mustard	0	0	0	0	0	0
Nectarine	0.74	0	0.12	0	1.19	2.05
Orange	0.01	0	0.33	0	0	0.34
Orange juice	0	0	0.22	0	0	0.22
Pancakes	0.40	0.04	0.01	3.92	0	4.37
Peanut butter	0.01	0	0	0	0	0.01

Pear	0.19	0	3.39	0	3.22	6.80
Pesto	1.83	0.03	0.01	0	0	1.87
Pine nuts		0.81	0	0	0	0.81
Pizza	0.21	0.05	0.21	0	0	0.47
Pork chop	0	0	0	0	0	0
Potato. boiled	0	0	0	0	0	0
Potatoe chips	0.22	0	0.08	0	0	0.30
Potatoe salad	0.33	0.01	0.01	0.78	0	1.13
Potatoe. fried	0	0	0	0	0	0
Pudding. almond	0	0	0	4.35		4.35
Pulses. cooked	0.54	1.16	0	0	0	1.70
Raisins	5.50		1.20	0	0	6.70
Raspberry	0.28	0	0.39	0	0.11	0.78
Rice porridge	0	0	0	2.51	0	2.51
Rice. cooked	0	0	0	0	0	0
Saladmix	0.07	0	0.17	0	0.02	0.26
Salmon. canned	0	0	0	0	0	0
Salmon.smoked	0	0	0	0	0	0
Salmon/Trout	0	0	0	0	0	0
Sauce. Bearnaise	0	0	0	0.66	0	0.66
Sauce. brown	0	0	0	0	0	0
Sauce. pasta	0.42	0.01	0.04	0	0	0.47
Sauce. salsa	1.28	0.03	0.29	0	0	1.60
Sauce. soya	0	0	0	0	0	0
Sausage bread	0.85	0.08	0.01	0	0.01	0.95
Sausage. Bologna	0.17	0	0	0.76	0	0.93
Sausage. chicken and turkey (grill)	0	0	0	0	0	0
Sausage. chicken and turkey (meat)	0	0	0	0	0	0

Sausage. grill	0	0	0	1.29	0	1.29
Sausage. meat	0	0	0	1.11	0	1.11
Sausage. meat (light)	0	0	0	0	0	0
Sausage. salami	0.21	0	0	0	0	0.21
Shellfish. cooked	0	0	0	0	0	0
Soda. light	0	0	0	0	0	0
Soda. original	0	0	0	0	0	0
Sour cream (10% fat)	0	0	0	4.20	0	4.20
Sour cream (20% fat)	0	0	0	3.70	0	3.70
Sour cream (35% fat)	0	0	0	2.90	0	2.90
Sour cream porridge	0.18	0.02	0	4.08	0	4.28
Spaghetti (cooked)	0.33	0.01	0	0	0	0.34
Spring rolls	0.52	0.02	0.02	0	0.01	0.57
Steak	0	0	0	0	0	0
Strawberry	0.04	0	0.15	0	0.08	0.27
Sunflower seeds	0.85	0.58	0.05	0	0	1.48
Sushi	0	0	0	0	0	0
Swede	0	0	0.14	0	0.22	0.36
Sweet spread (Sunda)	0	0	0.39	0	0	0.39
Taco	0.06	0	0.11	2.22	0	2.39
Tea. black	0	0	0	0	0	0
Tea. green	0	0	0	0	0	0
Tea. herbal	0	0	0	0	0	0
Tomato	0.05	0	0.36	0	0	0.41
Tomato soup	0	0	0	0	0	0
Tuna. canned	0	0	0	0	0	0
Turkey fillet	0	0	0	0	0	0
Vanilla sauce	0	0	0	3.85		3.85

Vegetable mix	0.02	0	0.14	0	0.33	0.49
Vegetable stew. Lapskaus	0	0	0.03	0	0.02	0.05
Waffles (light)	0.43	0.04	0.01	1.33	0	1.81
Water	0	0	0	0	0	0
Whipped cream	0	0	0	2.95		2.95
White cheese	0	0	0	0	0	0
White cheese. Norvegia	0	0	0	0	0	0
Wine. fortified	0	0	0	0	0	0
Wine. red	0	0	0	0	0	0
Wine. white (9-14%)	0	0	0	0	0	0
Wok	0.22	0.02	0.05	0	0.18	0.47
Wok. seafood	0.20	0.02	0.06	0	0.08	0.36
Wraps	0.68	0.07	0.01	0	0	0.76
Yoghurt. fruit	0	0	0	4.50	0	4.50
Yoghurt. fruit (light)	0	0	0	5.90	0	5.90
Yoghurt. Go'morgen (light)				5.25		5.25
Yoghurt. plain	0	0	0	5.60	0	5.60
Yoghurt. Rislunsj				3.80		3.80
Yoghurt. Skyr	0	0	0	4.00	0	4.00
Yoghurt. Skyr (blueberry)	0	0	0	4.00	0	4.00
Yoghurt. YT (with muesli)	0	0	0.01	4.50	0.03	4.54
Yohgurt. drinkable	0	0	0	4.20	0	4.20

Appendix IX: Detailed presentation of top ten dietary sources to fructan, GOS, excess fructose, lactose & polyols

Rank	Food	Fructan, g/day Mean [95% CI]	FOOD	GOS, g/day Mean [95% CI]	FOOD	Excess fructose, g/day Mean [95% CI]
1	**Onion, leek**	0.78 [0.70, 0.86]	**Bread >50% whole grain**	0.31 [0.28, 0.31]	**Apple juice**	0.89 [0.72, 1.10]
2	**Bread <50% whole grain**	0.70 [0.01, 0.78]	**Peas, beans**	0.11 [0.09, 0.12]	**Apple**	0.87 [0.77, 0.96]
3	**Bread >50% whole grain**	0.54 [0.49, 0.59]	**Bread <50% whole grain**	0.04 [0.03, 0.04]	**Pear**	0.29 [0.25, 0.33]
4	**Bread, white**	0.28 [0.26, 0.30]	**Bread, white**	0.03 [0.03, 0.04]	**Tomato**	0.22 [0.19, 0.26]
5	**Broccoli**	0.18 [0.16, 0.20]	**Cornflakes**	0.03 [0.03, 0.04]	**Fruit, dried**	0.20 [0.16, 0.25]
6	**Cereals**	0.18 [0.14, 0.21]	**Broccoli**	0.03 [0.02, 0.03]	**Cereals**	0.20 [0.16, 0.25]
7	**Pasta, noodles**	0.13 [0.12, 0.14]	**Onion, leek**	0.02 [0.01, 0.02]	**Sugar & sweets**	0.15 [0.13, 0.17]
8	**Vegetable mix**	0.06 [0.05, 0.06]	**Almonds**	0.01 [0.01, 0.02]	**Orange juice**	0.13 [0.11, 0.15]
9	**Grains, flour**	0.05 [0.04, 0.05]	**Walnuts**	0.01 [0.006, 0.01]	**Carrot**	0.08 [0.07, 0.08]
10	**Peas, beans**	0.05 [0.03, 0.06]	**Porridge**	0.01 [0.01, 0.02]	**Banana**	0.06 [0.06, 0.07]

GOS: galactooligosaccharides, excess fructose= fructose- glucose, 95% CI: 95% confidence interval.

Rank	Food	Lactose, g/day Mean [95% CI]	Food	Polyols, g/day Mean [95% CI]
1	**Semi-skimmed milk, 0.5% fat**	2.85 [2.84, 4.13]	**Candy without chocolate**	2.4 [2.10, 2.71]
2	**Yoghurt**	2.72 [2.33, 3.11]	**Lozenges, hard candy**	0.72 [0.60, 0.80]
3	**Semi-skimmed milk 1-1.2% fat**	2.45[1.97, 2.93]	**Cauliflower**	0.33 [0.29, 0.38]
4	**Chocolate**	1.42 [1.26, 1.58]	**Pear**	0.27 [0.27, 0.31]
5	**Skimmed milk**	1.07 [0.73, 1.42]	**Apple**	0.17 [0.14, 0.21]
6	**Brown whey cheese**	1.06 [0.87, 1.26]	**Apple juice**	0.17 [0.15, 0.19]
7	**Coffee**	0.96 [0.66, 1.27]	**Broccoli**	0.07 [0.06, 0.07]
8	**Full fat milk**	0.94 [0.64, 1.25]	**Vegetable mix**	0.05 [0.04, 0.06]
9	**Flavored milk**	0.87 [0.70, 1.04]	**Peas, beans**	0.03 [0.02, 0.03]
10	**Porridge**	0.70 [0.60, 0.79]	**Cereals**	0.02 [0.01, 0.02]