Do patients living with ulcerative colitis adhere to healthy eating guidelines? A cross-sectional study

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Abstract

Ulcerative colitis (UC) is an inflammatory bowel disease that causes gastrointestinal lesions, bleeding, diarrhoea and nutritional complications. Insufficient nutrient intake can additionally deteriorate nutritional status. The present cross-sectional study aimed to determine whether UC patients adhere to national dietary guidelines and to assess their dietary habits. An online questionnaire (n 93) was used to assess health-related conditions, current nutritional knowledge, professional dietary guidance and food avoidance. A 24 h dietary recall (n 81) was used to assess nutrient intakes, which were then compared with the national recommended intake values. The results showed that the nutritional knowledge of participants was limited with unofficial sources being used, including websites. Numerous food groups, predominantly fibre-rich foods and fruit and vegetables, were largely avoided by the participants. Almost half of the study population eliminated foods such as dairy products to alleviate symptoms, possibly unnecessarily. Energy intakes were significantly ($P<0.05$) lower than the national recommended intake values in women aged 18–65 years and men aged 18–60 years. Fat intake exceeded the national recommended intake values ($P<0.0001$), at the expense of carbohydrate and fibre intakes, which were significantly ($P<0.005$) lower than the national recommended intake values. Protein intake was significantly high in women aged 19–50 years ($P<0.00$) and men aged 19–50 years ($P<0.005$). Vitamin C, vitamin B_{12} and Ca intake levels were overachieved by all participants ($P<0.001$), while women aged 19–50 years did not achieve their dietary Fe reference nutrient intake levels ($P<0.001$). Osteopaenia, osteoporosis and anaemia were reported by 12, 6 and 31 % of the participants, respectively. Findings indicate that food avoidance may contribute to nutrient deficiencies in UC patients. Low intakes of these food groups, especially during remission, are preventing patients from adhering to dietary guidelines.

Key words: Food avoidance: Dietary intakes: Nutritional status: Deficiencies: Ulcerative colitis

Ulcerative colitis (UC) is an inflammatory bowel disease with an incidence rate of 10/100 000 people within the UK and a point prevalence of 200/100 000[1]. It is a chronic disease and is usually diagnosed between late adolescence and early adulthood and affects both sexes equally[1,2]. UC has a direct effect on patients' quality of life and is associated with numerous health complications such as toxic megacolon, strictures and colorectal cancer[3,4]. UC involves inflammation and development of ulceration on the lining the colon and rectum, collectively known as the large bowel[1]. Symptoms include ulcers and open wounds on the surface of the lining, possibly causing gastrointestinal bleeding, weight loss and diarrhoea[1]. UC patients will frequently report urgency for the toilet with more than five bowel movements per d[5]. Some may experience further problems outside the bowel including skin problems, ocular conditions, and musculoskeletal system, haematopoietic and coagulation system

complications[4]. The cause of UC is unclear, but research indicates a multitude of factors interacting together including genetics, immune responses and infective mechanisms[6]. In addition, ethnicity, age and geographical locality can have an impact on those affected by UC[6]. Western lifestyles, smoking, dietary habits and infections during childhood play a significant role, compounding the incidence rates of UC.

Due to bowel inflammation during heightened disease activity, nutritional requirements and habits may need to be changed to assist recovery and prevent aggravation of the bowel[7]. The consumption of smaller portions and reduced amounts of fibre and fatty foods is recommended as they exacerbate symptoms during disease flare-ups[6]. Avoidance of insoluble fibre is recommended while patients are in treatment, due to it being indigestible and attaching itself to the wall of the colon while inflamed[8]. This action aggravates the colon and can worsen symptoms. Soluble fibre is

alternatively recommended, with easier digestion, thereby not aggravating the inflamed bowel[8].

Despite conflicting evidence that diet is related to disease activity, patients are assured that diet is not the primary cause of UC[9]. Many patients associate symptoms with eating particular foods, frequently leading to avoidance of particular food groups, such as dairy products[6]. Perhaps due to misinterpretation of UC diet guidance or self-seeking information, some patients may experiment with elimination diets and cut out important food groups[6]. Some may be exposed to inaccurate information regarding UC diets and confuse symptoms with food allergies[10]. Consequently, patients might exclude foods that are required to adhere to healthy eating guidelines in efforts to alleviate UC symptoms[11]. Eating a variety of foods is essential for patients both in remission and in flare-ups to prevent possible nutrient deficiencies. Nutrient deficiencies may occur due to malabsorption from severe disease, loss of appetite, food avoidance and medication side effects, including lowered bone mineral density and vitamin D deficiency from steroid use and nutrient malabsorption[12–15].

Limited dietary guidance is provided to UC patients[15]. Some have learnt that excluding certain foods can prevent flare-ups or help when in treatment[6,9]. Little is known about patients' food choice and its effect on dietary requirements[16]. Currently, aside from complete enteral nutrition, there are no clinical diets that have been proven to reduce disease activity or symptoms. Yet, patients continue to eliminate certain foods to alleviate symptoms[17]. Research is needed to assess what foods patients are eliminating, whether any alternative replacements are being made, and what the resulting effects on dietary intake and health are. The aims of the present study were to compare the dietary intakes of UC patients in the UK with the national recommended dietary intake values and to determine whether food avoidance contributes to not achieving these recommended intake values.

Methods

Study design and participants

In the present cross-sectional study, the diet adequacy and food avoidance habits of UC patients in the UK were investigated. The study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the ethics committee of a UK Higher Education Institution. Written informed consent was obtained from all participants.

A total of ninety-seven UC patients were recruited across the UK from the National Association for Colitis and Crohn's Disease registers by e-mail, posts in UC forums and social media sites. The inclusion criteria were as follows: aged 18–65 years and no history of UC-related surgery.

A nineteen-question health questionnaire was used to assess UC patients' health-related conditions, current nutritional knowledge, professional dietary guidance and food avoidance. The participants were asked which foods they avoided (by a choice) and which foods they have excluded from their diet (complete elimination from the diet). Some other questions

included 'Do you have any of the following as a result from ulcerative colitis? Osteopenia, Osteoporosis, Anaemia or Other?', 'What would you consider your nutritional knowledge to be? Basic, Intermediate or expert?', 'Have you received any nutritional guidance concerning ulcerative colitis? Nothing, a little, quite a lot, a lot?', and 'Have you received any nutritional guidance from the following: Dietician, Nutritionist, Government sources, websites, books or other sources?'. The questionnaire was written, designed and accessed through the online database Survey Monkey. Dietary under-reporting was assessed by Goldberg cut-off limits[18].

Dietary intake data were collected using a 24 h dietary recall. Total energy intake (kJ/d), macronutrient intake (percentage of energy), fibre intake (g/d) and the intake of selected micronutrients were compared with the current national dietary intake values set by the Department of Health[11]. The percentage of energy derived from each macronutrient (carbohydrates, non-milk extrinsic sugars, protein, fat and SFA) was calculated by multiplying the weight of each nutrient in grams by the appropriate energy density and then by dividing the total energy intake. Fe, Ca, vitamin B_{12} and vitamin C intakes were compared with reference nutrient intake (RNI) values, and these are further discussed herein for the following reasons. Fe and Ca were chosen, as deficiency of these minerals poses higher risks of anaemia, osteopaenia and osteoporosis in UC patients[6]. Vitamin B_{12} was chosen due to its dietary sources being those that are frequently avoided by UC patients[6,15]. Vitamin C, most commonly found in fruit and vegetables, was additionally chosen to investigate as UC patients frequently report the foods containing vitamin C as a trigger for a relapse in their condition[19]

Initially, four participants participated in a pilot study to ensure that the questionnaire and 24 h dietary recalls were readable and not distressing.

Data analysis

Statistical tests were carried out using SPSS version 20.0 (SPSS Inc.). In the preliminary analysis, the data were screened for missing values, outliers and univariate normality.

Dietary intake records were analysed using WISP version 3.0 (Tinuviel Software) nutritional analysis software. Missing food items' nutritional data were manually entered into the software by either locating food composition from product manufacturers' websites or McCance and Widdowson's Composition of Foods integrated dataset (6th Summary, UK Nutrient Databank, 2002, UK). The dietary intakes of macronutrients and micronutrients were compared with the current national dietary values using one-sample t test. Descriptive statistics (frequencies and mean values) were applied for questionnaire data, including nutritional supplements used, food avoidance, nutritional knowledge and patterns of dietary elimination.

Results

Participant characteristics

Participant characteristics and frequency data are given in Table 1. The majority of the participants were aged between

Table 1. Participant characteristics and frequency data from the questionnaire (n 93)

Characteristics	Categories	Percentage
Sex	Female	73
	Male	22
Age (years)	31–50	52
	18–30	30
	51–65	14
UC duration (years)	0–10	72
	11–20	20
	20+	4
Severity of flare-up	Mild to moderate	22
	Mild	11
	Mild to severe	6
	Very severe	3
	Severe	2
Deficiencies as a result of UC	Anaemia	31
	Osteopaenia	12
	Other	9
	Osteoporosis	6
Nutritional guidance received	A little	39
	Nothing	38
	Quite a lot	16
	A lot	2
Nutritional sources of information used	Dietitian	22
	Websites	21
	Other	18
	Books	18
	Nutritionist	12
	Government sources	10
Nutritional knowledge	Basic	56
	Intermediate	34
	Expert	6
	Missing data	4
Referral to a dietitian or nutritionist	No	76
	Yes	24
	Missing data	4
Diets followed through media	No	69
	Yes	17
	Sometimes	9
	Missing data	5

UC, ulcerative colitis.

31 and 50 years (n 50). Females accounted for the majority of participation in the study (n 71, 73%). Male participation was notably lower (n 22, 23%). A large proportion (n 70, 72%) of the participants had been diagnosed with UC within the past 10 years. Nearly a third of the participants (n 25, 26%) were experiencing a flare-up of assorted severity, with a small number (n 2, 2%) being in remission. Professional dietary support proved to be limited with the majority of the patients (n 71, 73%) not being referred to a dietitian or nutritionist. Many received little or no dietary guidance, with only two participants (2%) reporting that they were given a lot of dietary help. Over half of the participants (n 54, 56%) reported to have basic nutritional knowledge, with various nutritional sources of information being used, including dieticians, official websites and books. Most did not experiment with media diets related to UC (n 67, 69%). Anaemia (n 30, 31%), osteopaenia (n 12, 12%), osteoporosis (n 6, 6%) and other nutrient deficiencies (n 9, 9%) were reported.

Dietary patterns

Dietary habits and preferences are shown in Figs. 1–3. Particular foods were continuously excluded by nearly half of the participants (n 47, 49%), with less than a third (n 27, 28%) occasionally excluding foods from their diets. Food avoidance was more predominant than food exclusion with fibre and fruit and vegetables being the most frequent food groups avoided. Other common food groups reported to be often avoided or excluded were milk and dairy products. The participants reported that their symptoms were alleviated a lot (n 24, 25%), a little (n 54, 56%) or not at all (n 11, 11%) by avoiding such foods. The participants described a mixture of feelings towards food avoidance and how they felt it affected their symptoms (Table 2). Most of the participants avoided these foods during both flare-ups and remission (n 55, 57%), whereas only few (n 25, 26%) avoided them during flare-ups. The most used dietary supplements (Fig. 3) were Ca (n 31, 32%), Fe (n 15, 16%), multivitamins (n 15, 16%), vitamin B_{12} (n 5, 5%), n-3 fatty acids (n 7, 8%), prebiotics and probiotics (n 6, 7%), fish oils (n 4, 4%), folic acid (n 3, 3%), Zn (n 3, 3%), vitamin C (n 2, 2%), vitamin D (n 2, 2%), herbal supplements (n 7, 8%) and other (n 7, 8%).

Food intakes

The food intakes of participants were compared with the national recommended intake values to assess whether they were adhering to dietary guidelines as shown in Figs. 4–6. The mean energy intake of all participants was 6364 kJ (1521 kcal) compared with the mean intake of 8025 kJ (1918 kcal) in males and females aged 19–64 years in the general population, emphasising reduced food consumption among these UC patients (Fig. 1). Energy intake was significantly low among the participants ($P < 0.05$), with only males (n 3, 33%) aged 61–65 years achieving the recommended energy levels. Carbohydrate (44% daily energy) and fibre (11 g/d) intakes, in particular, proved to
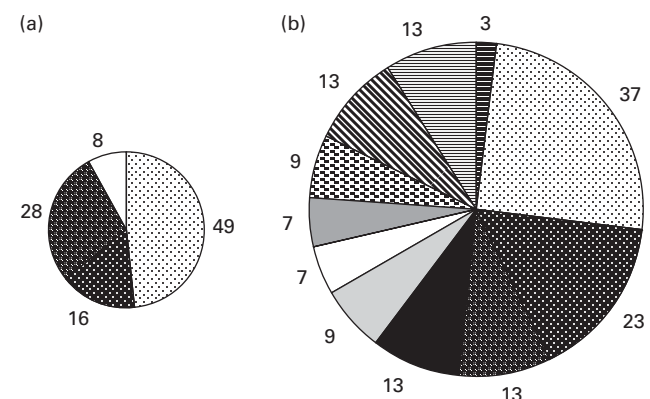

Fig. 1. Food exclusion patterns (expressed as percentage) of ulcerative colitis patients (n 93). (a) Food exclusion: ▨, yes; ▧, no; ▩, sometimes; □, not reported. (b) Foods excluded: ▤, starchy foods – bread, pasta, and potatoes; ▨, fruit and vegetables; ▨, high-fibre foods; ▨, milk and dairy products; ■, high-fat and sugary foods; □, wheat and gluten; □, red meat; ▪, fizzy drinks and caffeine; ▨, vegetable protein; ▨, spicy foods; ▤, alcohol.
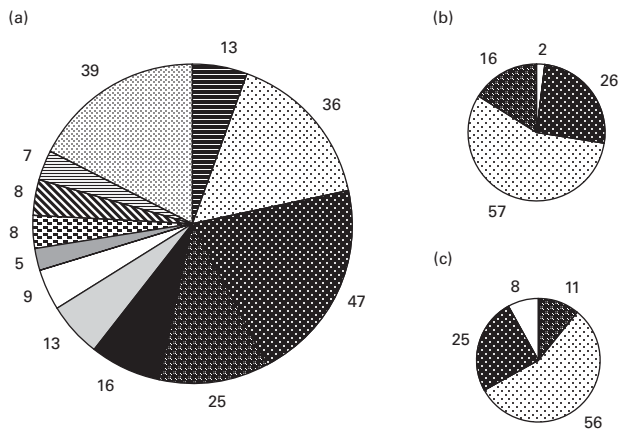
Fig. 2. Food avoidance patterns (expressed as percentage) of ulcerative colitis patients (n 93). (a) ▦, Starchy foods: bread, pasta, and potatoes; ▨, fruit and vegetables; ▨, high-fibre foods; ▨, milk and dairy products; ■, high-fat and sugary foods; ▨, wheat and gluten; ☐, red meat; ▨, poultry and fish; ▨, fizzy drinks and caffeine; ◩, vegetable protein; ▤, spicy foods; ▨, alcohol. (b) Time of avoidance: ☐, remission; ▨, flare-up; ▨, both; ▨, not reported. (c) Alleviation of symptoms: ▨, not at all; ▨, a little; ▨, a lot; ☐, not reported.

be significantly low (P<0·001) in this population. However, protein, total fat and saturated fat were consumed in excess (P<0·001).

Fe (8·8 mg/d v. RNI 14·8 mg/d; P<0·001) and Ca (573 mg/d v. RNI 700 mg/d; P<0·05) intakes were significantly lower than the national recommended values in females aged 18–50 years, but proved adequate in other age and sex groups of UC patients. Vitamin C was excessively (92 mg/d; P<0·001) consumed by females aged 18–50 years, while this trend was not observed in other UC patient groups. Vitamin B$_{12}$ intake was adequate among all groups, with females aged 19–50 years achieving more than the required intake levels (2·26 mg/d; P<0·05).

Discussion

UC affects both sexes equally and occurs in roughly one in five people in the UK[1]. Despite this, in the present study, females accounted for the majority of participation. Similar findings were reported by other researchers. A study investigating how young adults cope with inflammatory bowel disease concerns found that 80 % of the participants were women[20]. No current evidence suggests that males find it harder to cope with UC; however, research shows that males are less likely to seek medical help and are less proactive about their state of health[20,21], possibly explaining poorer male participation in the present study.

The energy intake of UC patients (Fig. 4) who participated in the present study was significantly lower than the estimated average requirements[11]. This is in accordance with studies showing malnutrition among UC patients[6,15,22]. Poor appetite, weight loss and low food consumption have been suggested to contribute to compromised energy intakes[15,22]. In the present study, 26 % of the participants avoided foods during flare-ups to alleviate symptoms (Fig. 2), and 44 % of the participants were flaring, possibly influencing the majority of participants not achieving adequate energy intake levels.

However, 57 % of the participants avoided foods both during remission and flare-ups, increasing the likeliness of deficiencies when food intakes should be adequate. Furthermore, only 2 % of the participants avoided foods during remission alone.

Although food avoidance was prevalent in 57 % of the participants, only 49 % reported that eliminating certain foods helped alleviate symptoms, indicating more people avoid foods than required. The thoughts of participants varied on how food affected their UC and alleviated symptoms (Table 2), despite the reassurance given to patients by health professionals that food does not affect disease activity[9]. Foods high in fibre were avoided by the most of the participants, followed by alcohol and fruit and vegetables (Fig. 2). Fibre intake was significantly low (P<0·001), with only 6 % achieving the recommended intake level of 18 g/d[11]. Fibre intake in the general population is also low, currently reported to be 13·8 g/d[23]. Nevertheless, lower consumption of fibre was anticipated in the participants as insoluble fibre and low-fibre foods are often recommended to prevent aggravation to the inflamed bowel[8]. Observation from the literature shows that there is conflicting advice provided to inflammatory bowel disease patients with regard to fibre intake[8,24]. Some sources recommend the consumption of low-fibre residue foods only during flare-ups, while others distinguish between soluble and insoluble fibre foods and recommend avoiding only insoluble fibre foods. This highlights the importance of consistency in national recommendations of dietary fibre intake for UC patients, including detailed differences in the types of fibrous foods, such as insoluble fibre foods, that should be avoided during relapse. Consistent advice and recommendations regarding the appropriate times to exclude fibre foods and to reintroduce them should be provided to UC patients. This would enable patients to make more informed choices, even when
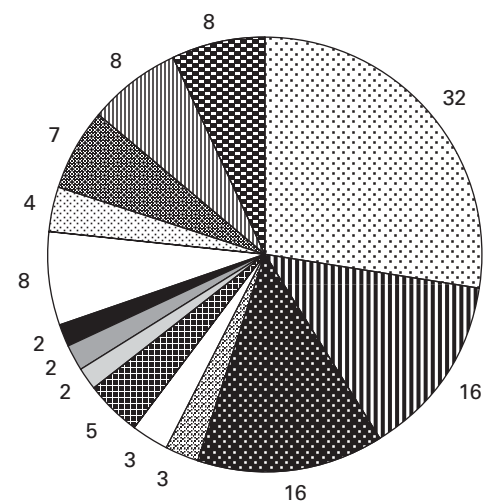

Fig. 3. Nutritional supplements used (expressed as percentage) by ulcerative colitis patients (n 93). ▨, Calcium; ▥, iron; ▨, multivitamins; ▨, folic acid; ☐, zinc; ▥, vitamin B$_{12}$; ☐, vitamin C; ▨, vitamin D; ■, vitamin E; ☐, n-3; ▨, fish oils; ▨, prebiotics and probiotics; ▥, herbal supplements: Echinacea, aloe vera, starflower, and primrose; ▨, other: glutamine, co-enzyme Q10, and turmeric.

Table 2. Thoughts of participants on food intakes

Participants	Quotes taken from participants regarding food intakes
Participant 4	'When flaring I go on the low residue diet but find it hard to eat anything due to severe nausea a lot of the time'
Participant 18	'When flaring I stick to plain bland food i.e. mashed potato/chicken etc'
Participant 59	'I eat white meat and fish but no red meat of any sort. I avoid certain vegetables such as broad beans. I can't tolerate spinach and chard. I avoid all gluten, I am on a very strict gluten free diet'
Participant 27	'I always limit my dairy intake – never milk or ice-cream. I do have probiotic yoghurts and a little cheese though. I avoid caffeine and wheat when ill'
Participant 51	'Everything not permitted on SCD is avoided. Especially high carb (grains), dairy (excluding cheese and 24 h fermented yoghurt) and refined sugar'
Participant 56	'I have cut out white bread from my diet completely and switch to lactose free milk and butter. During a flare up I have to remove red meat, fruit and most vegetables from my diet and slowly introduce when my symptoms improve'
Participant 32	'Tried cutting them out individually, but didn't have any effect'

SCD, specific carbohydrate diet.

individual differences may need to be taken into account. Consequently, patients may be excluding both insoluble and soluble fibre foods due to misunderstanding their difference from conflicting advice, highlighting the importance of adequate and consistent professional dietary advice and guidance. The consumption of fruit and vegetables is currently recommended depending on the cooked state and fibre content[8]. For example, low consumption of fibre cooked fruit and vegetables, without skins, rather than that of raw and uncooked high-fibre fruit and vegetables is recommended. Yet, avoidance of fruit and vegetables was reported by 36% of the participants. This is comparable to that of the general population, as fruit and vegetable intake is below the recommended levels, with adults aged 19–64 years consuming 4·2 portions/d[23]. High fibre content may have encouraged further avoidance of fruit and vegetables by the participants, preventing them from eating an essential food group regardless of dietary advice (Table 2). Wheat and gluten-containing products were avoided by 13% of the participants and excluded by 9%, highlighting a difference between food avoidance and food exclusion. Limiting the consumption of these foods is not commonly advised; therefore, the participants may be practising unnecessary exclusion and perhaps confusing symptoms with food allergies[10]. This can also be applied to avoidance of dairy products, which featured among 25% of the UC patients and excluded by 13%. This correlates with the results of studies highlighting avoidance of dairy products to alleviate symptoms[6,9,25]. The percentage of participants who avoided dairy products was higher than the proposed 10–20% who suffer from dairy intolerance[26]. This suggests that UC patients who are not dairy intolerant may avoid dairy products needlessly, as suggested by Mishkin[26]. Yet, some argue that avoidance of dairy products is more common in inflammatory bowel disease patients than in the general population, possibly explaining greater avoidance[25]. This may affect those with osteopaenia and osteoporosis, a possible risk factor for patients[9,25]. Despite research emphasising protein derived from meat, particularly red meat, as a trigger for worsening UC activity[27–29], very few participants avoided red meat, with only one participant avoiding poultry and fish (Fig. 2).

Limited nutritional guidance can result in food avoidance[6]. Some argue that dietary advice is essential straight after

diagnosis to ensure suitable intakes of the appropriate foods to prevent malnutrition[6]. In the present study, 37% of the participants received no dietary guidance and only 24% were referred to a dietitian or nutritionist after diagnosis, coinciding with findings of restricted access to dietary services[6]. Subsequently, research suggests that UC patients may seek information from unreliable sources and experiment with food avoidance and exclusion to alleviate symptoms[6,9]. In the present study, many participants acquired information through unofficial sources including websites and books. The amount of reliable information found outside professional guidance is unclear, possibly causing exclusion of wrong foods[6]. In addition to this, inadequate nutritional knowledge may affect the patients' decision to eliminate and experiment
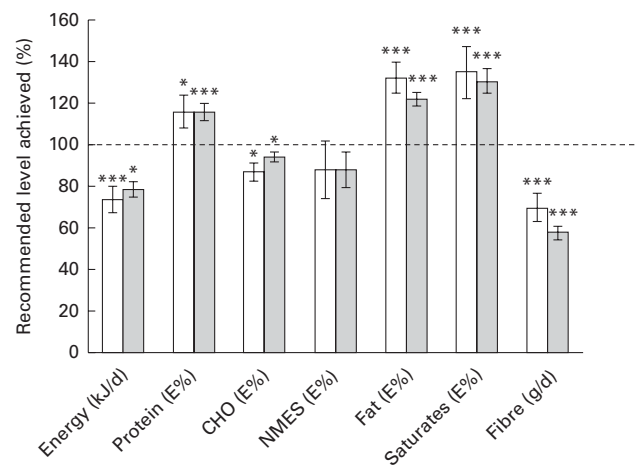
Fig. 4. Comparison of the mean daily macronutrient intake values of ulcerative colitis patients (n 81) and dietary reference values (DRV). - - - represents cut-off point for the estimated average requirements for energy DRV for macronutrients set by the Department of Health[11]. The following reference values were used: energy – 8117 kJ/d (1940 kcal/d) for females (□) aged 18–50 years; 7950 kJ/d (1900 kcal/d) for females aged 51–65 years; 10 669 kJ/d (2550 kcal/d) for males (□) aged 19–59 years; 9958 kJ/d (2380 kcal/d) for males aged 60–64 years; protein – 15% of total daily energy intake; carbohydrates (CHO) – 47% of total daily energy intake; non-milk extrinsic sugars (NMES) – 10% of total daily energy intake; fat – 33% of total daily energy intake; saturates – 10% of total daily energy intake; fibre – 18 g/d. Values are means, with standard errors represented by vertical bars. Mean value was significantly different from the national recommended intake value set by the Department of Health[11]: * P<0·05; *** P<0·001. E%, percentage of energy.
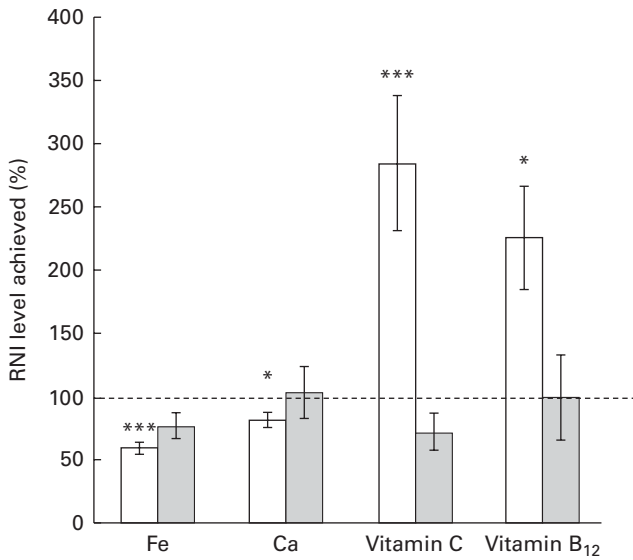
Fig. 5. Comparison of the mean daily micronutrient intake values of female ulcerative colitis patients (n 62) and reference nutrient intake (RNI) values. --- represents cut-off point for the RNI set by the Department of Health[11]. The following reference values were used: iron – 14·8 mg/d for 19–50-year-old females (□) and 8·7 mg/d for 51–65-year-old females (▨); calcium – 700 mg/d for all female participants; vitamin C – 40 mg/d for all female participants; vitamin B$_{12}$ – 1·5 mg/d for all female participants. Values are means, with standard errors represented by vertical bars. Mean value was significantly different from the national recommended intake value set by the Department of Health[11]: * P<0·05; *** P<0·001.

with the guidance provided. In the present study, 56 % of the participants reported that they considered themselves to have basic nutritional knowledge, potentially making them vulnerable to misinterpretation of evidence. Furthermore, 69 % of the participants did not follow media-related diets to alleviate their UC, but the remaining participants had followed various unknown and unofficial UC diets.

In terms of macronutrient intake, the diets of UC patients who participated in the present study were lacking carbohydrates and fibre, while they were abundant in protein and fat. Carbohydrate intake was low with only 34 % achieving the national recommended levels (Fig. 4). This value is somewhat lower than that found in the study of Prescha et al.[25], in which the mean daily intake percentage for females was 51 % and that for males was 48 % compared with 44 % in all participants of the present study. Only three participants excluded complex carbohydrates to alleviate symptoms, indicating that low intakes may be influenced by disease activity and reduced appetite[15,25]. Additionally, the participants did not overconsume non-milk extrinsic sugars[11] (Fig. 4). This may contribute to low carbohydrate intakes due to 13 % reporting that avoidance of sugary foods helped alleviate symptoms. However, low exclusion of complex carbohydrates suggests that less people experience symptoms associated with this food group, giving less reason for elimination diets[5,17]. Fat intake percentages were significantly higher (P<0·001) than the dietary reference values with a mean intake of 37 %. The results are similar to findings from the study of Prescha et al.[25], in which the fat intake percentages of participants,

notably males, were higher at 38 %, while their carbohydrate intake percentages were below the recommended levels at 48–51 %. The participants of the present study reported consuming butter and confectionery, despite advice to reduce the consumption of fat-rich foods. High intakes of fat, specifically linoleic acid, are associated with increased incidence rates of UC[30]. Excessive fat intake indicates poor patient compliance to professional dietary advice, particularly as surplus dietary fat has been shown to worsen the symptoms[30].

A significant proportion of the participants (P<0·001) were achieving vitamin B$_{12}$ intake above and beyond the recommended levels. The main dietary sources of vitamin B$_{12}$ are milk and meat sources; the participants are likely to derive vitamin B$_{12}$ from meat, fish and alternative sources due to reduced intakes of dairy products. Although previous studies have linked protein foods with increased relapse[28,29], all participants of the present study achieved RNI levels for protein, indicating that vitamin B$_{12}$ was obtained from meat and poultry sources with some age groups consuming excessive protein. High consumption of protein is sometimes advised due to the loss of protein in the large bowel from inflammation, immune responses, tissue repair and increased metabolic requirements[25,31]. Prescha et al.[25] argue that 17 % additional energy should be consumed via protein, ideally poultry, fish and well-tolerated dairy products, during early remission because of its crucial role in the treatment of the disease, allowing the patients to recover more successfully. Exclusion of dairy products by the participants appears to have little impact on overall protein intake, as other sources were not excessively avoided (Figs. 2 and 4). Vitamin C was another vitamin that the participants, excluding females aged
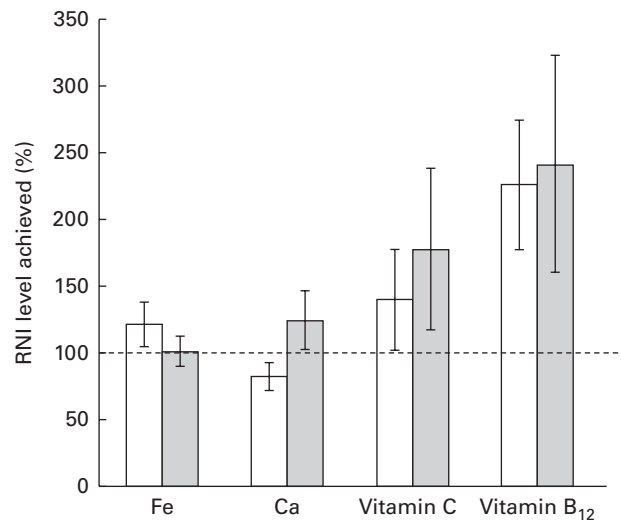

Fig. 6. Comparison of the mean daily micronutrient intake values of male ulcerative colitis patients (n 18) and reference nutrient intake (RNI) values. --- represents cut-off point for the RNI set by the Department of Health[11]. The following reference values were used: iron – 8·7 mg/d; calcium – 700 mg/d; vitamin C – 40 mg/d; vitamin B$_{12}$ – 1·5 mg/d for all male participants. Values are means, with standard errors represented by vertical bars. Mean value was significantly different from the national recommended intake value set by the Department of Health[11]: □, 19–50-year-old males; ▨, 51–65-year-old males.

51–65 years, consumed excessively ($P < 0.001$) compared with RNI levels; therefore, vitamin C food sources are less likely to be excluded and this vitamin is likely to be gained from sources other than fruit and vegetables.

Ca intake was significantly low ($P < 0.009$) in females aged 19–50 years, with 31% overall achieving RNI levels with a mean intake of 602·37 mg/d, which is 41 mg lower than that of the participants of the study carried out by Prescha et al.[25] (Figs. 2 and 3). UC patients are particularly vulnerable to developing low bone mineral density, osteopaenia and osteoporosis from steroid use, malabsorption and dairy product avoidance[6,9,25]. Associated health conditions were prevalent among 12% of the participants with osteopaenia and 6% with osteoporosis in the present study. Half of the participants had only been diagnosed with UC within the past 5 years; therefore, deficiency risks may be even higher among those who have been diagnosed for a longer period (Table 1). Some argue that patients require daily Ca supplements at 1000 mg to account for dairy product avoidance[6]. Nevertheless, only 32% of the participants took Ca supplements. Dietary intake analysis does not factor in nutritional supplements due to dosages and amounts not being provided by the participants.

Fe stores are frequently low due to intolerance and elimination of Fe-rich foods, blood loss and gastrointestinal sores[6,17]. Anaemia can occur in up to 80% of patients, highlighting the need for prevention[6]. Asakura et al.[32] found that animal produce increased relapse in patients, potentially leading to meat exclusion. However, in the present study, the poultry intake of participants was adequate and red meat was eliminated by only 7% of the participants (Fig. 1). Low Fe intake may be explained by the lower consumption of vegetables due to high avoidance. However, bioavailability is greater from meat sources, suggesting that reduced energy intake greatly affects Fe intake. Anaemia was present among 31% of the participants and yet only 16% took supplements, suggesting that the affected patients may endure the deficiency to avoid taking supplements, fearing side effects and unmanageability as previously found in up to 21% of UC patients[17,27,33,34]. Fe intake was significantly low in females aged 18–50 years ($P < 0.001$) with only 15% achieving RNI levels. Females aged 51–65 years consumed less than the recommended levels, but showed no significant difference when compared with the recommended levels. Fe intake among males was adequate, implying significant blood loss rather than low Fe intake to be the primary problem in female patients[11]. The difference among the participants is probably due to females aged between 18 and 50 years requiring higher RNI levels to account for greater blood loss during menstruation[11]. If food intakes are generally low, achieving RNI levels will be difficult, specifically within this group. Healthy females sometimes require additional intakes or supplements for excessive blood loss through menstruation. This highlights the additional risk of Fe deficiency in young female patients.

Conclusion

The present results highlight obvious avoidance of food groups, in particular, fibre, alcohol, and fruit and vegetables.

Foods recommended by health professionals to be excluded during treatment and flare-ups were generally avoided, but the participants displayed poor compliance elsewhere such as excessive fat intake. The participants were not achieving appropriate energy intake levels, resulting in low carbohydrate, Ca and Fe intakes among younger females, emphasising poor adherence to healthy eating guidelines. However, it is important to consider that intakes will vary when in remission or flare-ups as symptoms often discourage many from eating. Food intakes could have improved had professional dietary guidance been consistently provided. Health services disappoint participants in dietary guidance despite being a crucial knowledge source, leading many to eliminate foods and research elsewhere to alleviate symptoms, regardless of its accuracy. Perhaps with immediate interventions, deficiencies may decrease where non-essential food avoidance exists, particularly during remission. Still, this may be difficult to achieve as patients react differently to certain foods, leaving them to develop their own dietary habits that may not adhere to recommendations.

Limitations

It would have been advantageous to increase male participation to further address sex differences in food intakes. A more evenly distributed age range would have been valuable to assess factors such as osteoporosis risk among older participants. Additionally, the accuracy of 24 h dietary recall could be questioned, as it may not have provided the true reflection of habitual intake of the participants. For more accurate dietary intake analysis, it would have been highly valuable to gain information on participants' supplement dosages to establish their contribution to nutrient intakes.

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References

1. Ho G, Lees C & Satsangi J (2011) Ulcerative colitis. *Inflamm Bowel Dis* **39**, 224–228.
2. Loftus EV Jr (2004) Clinical epidemiology of inflammatory bowel disease: incidence, prevalence, and environmental influences. *Gastroenterology* **126**, 1504–1517.
3. Hart AR, Luben R, Olsen A, et al. (2008) Diet in the aetiology of ulcerative colitis: a European prospective cohort study. *Digestion* **77**, 57–64.

4. Danese S & Fiocchi C (2011) Ulcerative colitis. N Engl J Med 365, 1713–1725.
5. Nikolaus S & Schreiber S (2007) Diagnostics of inflammatory bowel disease. Gastoenterology 133, 1670–1689.
6. Lomer MCE (2011) Dietary and nutritional considerations for inflammatory bowel disease. Proc Nutr Soc 7, 329–335.
7. Neuman M & Nanau RM (2012) Inflammatory bowel disease: role of diet, microbiota, life style. Transl Res 160, 29–44.
8. Colitis UK (2011) The Effects of Diet on Ulcerative Colitis. Buckinghamshire: Colitis UK. http://www.ulcerativecolitis.org.uk/dietarychanges.htm (accessed January 2013).
9. Magee E, Edmond L, Tasker S, et al. (2005) Associations between diet and disease activity in ulcerative colitis patients using a novel method of data analysis. Nutr J 4, 7.
10. Moneret Vautrin DA, Sainte-Laudy KD & Kanny G (2001) Ulcerative colitis possibly due to hypersensitivity to wheat and egg. Allergy 56, 458–459.
11. Department of Health (1991) Dietary Reference Values for Food Energy and Nutrients for the United Kingdom: Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy. London: HMSO.
12. National Institute for Health and Care Excellence (2010) Clinical Knowledge Summaries: Ulcerative Colitis Management. http://www.cks.nhs.uk/ulcerative_colitis/management/scenario_established_ulcerative_colitis#-453637 (accessed February 2013).
13. Kuwabara A, Tanaka K, Tsugawa N, et al. (2009) High prevalence of vitamin K and D deficiency and decreased BMD in inflammatory bowel disease. Osteoporos Int 20, 935–942.
14. Lochs H (2010) Basics in clinical nutrition: nutritional support in inflammatory bowel disease. e-SPEN 5, 100–103.
15. Lucendo AJ & Rezende LC (2009) Importance of nutrition in inflammatory bowel disease. World J Gastroenterol 15, 2081–2088.
16. Hartman C, Eliakim R & Shamir R (2009) Nutritional status and nutritional therapy in inflammatory bowel diseases. World J Gastroenterol 15, 2570–2578.
17. Yamamoto T, Nakahigashi M & Saniabadi AR (2009) Review Article: diet and inflammatory bowel disease – epidemiology and treatment. Aliment Pharmacol Ther 30, 99–112.
18. Goldberg GR, Black AE, Jebb SA, et al. (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. derivation of cut-off limits to identify under-recording. Eur J Clin Nutr 45, 569–581.
19. Jowett SL, Seal CJ, Phillips E, et al. (2004) Dietary beliefs of people with ulcerative colitis and their effect on relapse and nutrient intake. Clin Nutr 23, 161–170.
20. Gray J & Clarke K (2006) A Research Project into the Role of NACC in Addressing the Concerns and Needs of Young People with IBD. National Association of Crohns and Colitis. St Albans: NACC. https://www.nacc.org.uk/downloads/IBDandmeFinalReport.pdf (accessed April 2013).
21. O'Brien R, Hunt K & Hart G (2005) 'It's caveman stuff, but that is to a certain extent how guys still operate': men's accounts of masculinity and help seeking. Soc Sci Med 61, 503–516.
22. Geering BJ, Badart-Smook A, Stockbrugger RW, et al. (2000) Comprehensive nutritional status in recently diagnosed patients with inflammatory bowel disease compared with population controls. Eur J Clin Nutr 54, 514–521.
23. Department of Health (2011) National Diet and Nutrition Survey: Headline Results from Years 1 and 2 (Combined) of the Rolling Programme (2008/9–2009/10). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/152235/dh_128542.pdf.pdf (accessed March 2013).
24. National Association for Crohn's and Colitis (2012) Food and IBD. St Albans: NACC. http://www.crohnsandcolitis.org.uk/Resources/CrohnsAndColitisUK/Documents/Publications/Booklets/Food%20and%20IBD.pdf (accessed February 2013).
25. Prescha A, Pieczynska J & Biernat K (2010) Nutritional status assessment of patients with inflammatory bowel disease. Gastroenterology 17, 25–31.
26. Mishkin S (1997) Dairy sensitivity, lactose malabsorption, and elimination diets in inflammatory bowel disease. Am J Clin Nutr 6, 564–567.
27. Tilg H & Kaser A (2004) Diet and relapsing ulcerative colitis: take off the meat? Gut 53, 1399–1401.
28. Jowett SL, Seal CL, Pearce MS, et al. (2004) Influence of dietary factors on the clinical course of ulcerative colitis: a prospective cohort study. Gut 53, 1479–1484.
29. Ripoli J, Miszputen J, Ambrogini O Jr, et al. (2010) Nutritional follow-up of patients with ulcerative colitis during periods of intestinal inflammatory activity and remission. Arg Gastroenterol 47, 49–55.
30. Tjonneland A, Overvad K, Bergmann MM, et al. (2009) Linoleic acid, a dietary n-6 polyunsaturated fatty acid, and the aetiology of ulcerative colitis: a nested case–control study within a European prospective cohort study. Gut 58, 1606–1611.
31. Gerasimidis K, McGrogan P & Edwards CA (2011) The aetiology and impact of malnutrition in paediatric inflammatory bowel disease. J Hum Nutr Diet 24, 313–326.
32. Asakura H, Suzuki K, Kitahora T, et al. (2008) Is there a link between food and intestinal microbes and the occurrence of Crohn's disease and ulcerative colitis? J Gastroenterol Hepatol 23, 1794–1801.
33. James SL, Irving PM, Gearry RB, et al. (2008) Management of distal ulcerative colitis: frequently asked questions analysis. Intern Med J 38, 114–119.
34. Gasche C, Lomer MCE, Cavill I, et al. (2004) Iron, anaemia, and inflammatory bowel diseases. Gut 53, 1190–1197.