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ORIGINAL ARTICLE

Diet and bowel symptoms among colon cancer survivors

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ABSTRACT

Background: Survival from colon cancer (CC) has improved considerably over the last decades, yet many survivors suffer from late sequelae from treatment. Typical symptoms of bowel dysfunction after treatment of CC are diarrhea, urge for defecation, fecal incontinence, bloating and constipation. Most CC survivors make dietary changes to alleviate bowel symptoms. We aimed to describe the self-perceived effects of diet on bowel function among CC survivors and the level of dietary information given.

Materials and methods: In this cross-sectional study, CC patients from four surgical departments in Denmark completed surveys regarding the effects of diet on their bowel function and whether they had previously received dietary advice. Data concerning sociodemographic characteristics and the surgical procedure (right-sided or left-sided hemicolectomy) were collected from the Danish Colorectal Cancer Group database. Forty-four healthcare professionals specialized in CC completed a questionnaire on how they advise CC. Descriptive statistics were applied.

Results: Among 1544 patients invited, 1239 (80.4%) responded, and 844 met the inclusion criteria (53% males, median age 72.6 years, median time since surgery 742 days). Among these, 267 (32%) reported that food affected bowel function. Fat was perceived to have a negative effect in 193 (25%), spices in 149 (19%), sweets in 101 (13%) and meat in 99 (13%). There was no association between tumor site and food categories affecting bowel function ($p = 0.078$). Most healthcare professionals (93%) stated that their unit gave advice about diet, but only 24% of patients remembered such information.

Conclusion: One-third of CC survivors perceive that food items, especially fat and spices have a negative impact on their bowel function. We found a major discrepancy between healthcare professionals reporting that they provide advice and the proportion of patients remembering this. There is an unmet need for further recognition of the role of diet in CC rehabilitation and for intervention studies of treatment principles.

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Colon cancer; sequelae; complications; diet; symptoms

Background

Colon cancer (CC) is the third most common cancer affecting approximately 3% of adults during their lifetime [1,2]. Surgery is the main treatment for CC and some patients receive adjuvant chemotherapy [3]. Survival from CC has improved considerably over the last decades, yet many CC survivors suffer from late sequelae from treatment [4–7]. Bowel dysfunction is common late sequelae and its consequences for survivors' quality of life may be severe [4,5,8,9].

Typical symptoms of bowel dysfunction after treatment of CC are diarrhea, urge for defecation, fecal incontinence, bloating and constipation [4,6]. Observational studies have indicated an association between diet and bowel symptoms with the consequence that many CC survivors make dietary and behavioral changes [10]. Hence, it is a general recommendation to add dietary advice to the treatment of bowel symptoms [11–15]. Unfortunately, there is a lack of awareness, consensus and evidence behind the dietary information given [16]. It appears that the information and advice are inconsistent and may give rise to confusion [16]. Furthermore, lifestyle advice including a high fiber intake aiming to reduce the risk of cancer recurrence [17] might worsen some symptoms caused by the surgical treatment [12,15,16].

The typical bowel symptoms after treatment of CC depend on the surgical procedure and maybe on whether

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adjuvant chemotherapy is given [11]. Loose stools, urgency and frequent bowel movements are most common after right-sided resections and may be caused by bile acid malabsorption or small intestinal bacterial overgrowth [4,5,13,14]. In contrast, constipation, bloating, incontinence for flatus and incomplete rectal evacuation are common symptoms in patients treated with a left-sided resection [6]. Usually, the dietary advice given to CC survivors does not take this difference into account [18,19], although a substantial proportion of CC survivors seems to benefit from specific medical treatment and simple dietary intervention [13,14].

Our hypotheses were that patients would report a number of food items to affect their bowel function and that patients who had undergone a right-sided resection would report intolerance to fat, while those who had undergone left-sided resection would report symptoms from a diet high in fiber. We also hypothesized that healthcare professionals (surgeons, nurses and dietitians) would give dietary advice depending on the surgical procedure and symptoms and that patients would recall dietary advice provided by healthcare professionals in the present study. We aimed to present systematically collected data from a large, well-defined cohort of Danish CC survivors to determine the perceived effects of daily diet on bowel function. We also aimed to compare the level of dietary information provided by healthcare professionals with the patients' perception of having received such information.

Materials and methods

Patient reported effect of food items

In this cross-sectional study, surgically treated colorectal cancer (CRC) patients from four surgical departments in North and Central Denmark Regions (covering a population of approximately 1.9 MIO) were invited to participate in a survey investigating late sequelae, diet and bowel symptoms after CRC. The survey was made between April 2018 and December 2020. The methodology including the data collection procedure is presented in detail elsewhere [7]. In brief, included patients received questionnaires regarding common late sequelae 3, 12, 24 and 36 months after surgery. Patients older than 18 years treated at the surgical departments at Aalborg, Randers, Viborg or Aarhus Hospitals, Denmark, were eligible for inclusion if treated for CRC with resectional surgery with or without chemo/radiotherapy. Exclusion criteria were age younger than 18 years, patients living in other regions of the country, linguistic barriers, cognitive impairment, patients undergoing local excision and patients with advanced tumors (tumor growth beyond the mesorectal/mesocolic fascia, histopathological pT4 tumor with invasion of adjacent structures or peritoneal carcinomatosis) or a permanent stoma.

Inspired by the questionnaire used in the study of Sun et al. [10], CC patients completed a survey consisting of 23 items covering bowel dysfunction, three regarding relevant medication, 10 items on the effect of food categories on bowel function, and 8 on quality of life. It was primarily distributed electronically, while a paper version was sent by mail to non-internet users. Patients who perceived that diet affected their bowel function were asked whether the following items made their bowel function better or worse: fruits, vegetables, red meat, fats and fatty foods, dairy, sweets, spices and spicy food, coffee and tea, carbonated drinks and alcohol. The questionnaire also included questions about bowel function using "Low Anterior Resection Syndrome score" (LARS) [20], "Wexner Incontinence Score" [21], "Skt Mark's Incontinence Score" [22] "Patient Assessment of Constipation Symptoms" [23], and stool consistency ("Bristol Stool Chart") [24]. In addition, they were asked about the use of fiber supplements, laxatives, antidiarrheal medication, any dietary information received from healthcare professionals during or after treatment, other sources of dietary information, and the impact of bowel function on quality of life. The study was registered in the Central Denmark Region's register of research projects (no. 1-16-02-972-17) and all participants gave informed consent. The STROBE cross-sectional reporting guidelines were used [25].

For the present paper, we extracted survey responses from CC patients and data from the last survey completed. Only patients who were at least 12 months post-surgery were included in the analysis.

From the Danish Colorectal Cancer Group database, we collected data on age, sex, height, weight, performance status, type of cancer, tumor site, Union for International Cancer Control (UICC) stage [26], and the surgical procedure. The surgical procedure was dichotomized to left- or right-sided (including transverse colon) resection. Information regarding chemotherapy was obtained from the patient charts. Missing data were coded specifically and left out of the analysis.

Clinician's dietary guidance to CC patients

Between January and March 2020, 46 healthcare professionals, including 18 surgeons, 19 nurses and 9 dieticians all specialized in the treatment of CC and with a median professional experience; treating such patients of 19 years (range 5–40) received a 15 items questionnaire. Among these, 44 (95.6%) responded. Information obtained included professional experience and discipline, whether CC patients treated at their institution were given information on diet, and if so, their usual advice about fiber supplement laxatives, bile acid sequestrants or antidiarrheal medication.

Data analysis

Statistical analysis was performed in Stata 14 [27]. Descriptive analyses are presented as *n* (%), mean (SD), and median (IQR) depending on the type and distribution of the data. Groups were compared with Fischer's exact test only and $p < 0.05$ was considered statistically significant.

Results

From April 2018 to December 2020, 1544 CC patients were invited to answer the questionnaire, either electronically or by ordinary mail. Among these, 1239 (80.2%) responded.

Table 1. Cancer stadium, treatment and demographic data for the 844 respondents.

Smokers *n* (%)	113 (13)
Alcohol, items per week = 0–14, *n* (%)	721 (85)
Alcohol, items per week = 15–>21 *n* (%)	81 (10)
Charlson score = 0, *n* (%)	426 (50)
Charlson score = 1–2, *n* (%)	320 (38)
Charlson score =/> 3 *n* (%)	98 (12)
Performance status = 0, *n* (%)	559 (66)
Performance status = 1, *n* (%)	201 (24)
Performance status = 2, *n* (%)	40 (5)
Performance status = 3, *n* (%)	10 (1)
UICC stadium 0, *n* (%)	2 (0.3)
UICC stadium I, *n* (%)	229 (27)
UICC stadium II, *n* (%)	284 (34)
UICC stadium III, *n* (%)	244 (29)
UICC stadium IV, *n* (%)	63 (7)
Right-sided resection (%)	469 (56)
Left-sided resection *n* (%)	375 (44)
Chemotherapy before surgery, yes, *n* (%)	9 (2)
Chemotherapy after surgery, yes, *n* (%)	256 (30)

Due to missing values, not all percentages may add to 100.

Patients were excluded from the analysis if their last survey was completed less than 12 months after surgery ($n = 322$), if they had a stoma ($n = 54$) or if clinical data were missing ($n = 19$). Thus, data from 844 patients, 447 (53%) males, were included in the analyses. The median (IQR) age at the time of the survey was 72.6 (65.4–78.1) years and the median (IQR) BMI was 26 kg/m^2 (23.3; 29.4)). Median (IQR) days since surgery was 742 (381–1102). A right-sided resection had been performed in 469 (including 12 resections of the transverse colon, and 9 colectomies), left-sided in 375 (Table 1). In total, nine (2%) patients had received pre-operative chemotherapy and 256 (30%) had received post-operative chemotherapy (Table 1).

Patient's perspective

Self-rated bowel function was very good in 164 (20%), good in 361 (43%), acceptable in 250 (30%), and poor or very poor in 63 (7%). Poor or very poor bowel function was reported by 39 (8.5%) patients having undergone a right-sided resection and 24 (6%) with a left-sided resection. One hundred and fifty-five (19%) (right-sided 97 (21%) and left-sided 68 (15%)) reported that bowel function affected their quality of life "some" or "a lot."

Effects of diet

A wide array of foods was perceived to either worsen or improve bowel function (Table 2). The food categories most commonly reported to have a negative effect on bowel function were fat ($n = 193$ (25%)), spices ($n = 149$ (19%)), sweets ($n = 101$ (13%)) and meat ($n = 99$ (13%)) (Table 2). Eighty-three (11%) of patients perceived that alcohol caused bowel symptoms. The food categories most commonly perceived to improve bowel function were vegetables ($n = 166$ (21%)), fruits ($n = 117$ (15%)) and dairies ($n = 95$ (12%)) (Table 2). We found no statistically significant difference between right- and left-sided resections with regard to the effect of food items on bowel function ($p = 0.078$).

Dietary supplements and medication

Fiber supplements were commonly taken by 236 (29%), anti-diarrheal agents by 53 (6%) and bulking agents by 132 (16%) (Table 3). Bulking agents were more often taken by patients having a left- than a right-sided resection ($p = 0.036$).

Dietary information received during treatment

A total of 198 (24%) patients reported that they had received any information about diet during either treatment or follow-up (Table 2). There was no difference between men ($n = 115$ (26%)) and women ($n = 83$ (21%)), ($p = 0.094$), but more patients </=73 years ($n = 125$ (29%)) than >73 years ($n = 73$ (18%)) recalled that they had been informed about diet ($p < 0.002$). Almost one-third of the patients ($n = 221$ (27%)) had independently sought information about diet and nutrition in relation to their previous disease or current symptoms. More women ($n = 121$ (31%)) than men ($n = 100$ (23%)) had sought information about diet ($p < 0.032$). More patients </= 73 years ($n = 166$ (38%)) than patients >73 years ($n = 55$ (14%)) had sought information about diet ($p < 0.001$).

Clinician's perspective

Overall, the majority of healthcare professionals ($n = 41$ (93%)) stated that their unit gave information about diet and fiber supplement to CC survivors. Twenty-nine healthcare professionals (66%) stated that their unit gave specific dietary advice about certain food or liquids. The dietary advice proposed by healthcare professionals is illustrated in Table 4. Almost all healthcare professionals ($n = 42$ (95%)) would recommend fiber supplements for patients with diarrhea after either right- or left-sided resections. The prescription of medication (bile acid sequestrants and anti-diarrheal) was only made by doctors. Thus, nine surgeons (53%) would prescribe bile acid sequestrants to patients with diarrhea after a right-sided resection (Table 5).

Discussion

The present study is the first large-scale study to focus on CC survivors' diet and gastrointestinal late adverse effects of the cancer treatment. Data were collected from a well-defined cohort of Danish CC survivors and the response rate was above 80%. The main finding was that 32% of respondents perceived that certain food items affected their bowel function. This included 25% who found that fat and 19% who reported that spicy food worsened bowel symptoms. Contrary to our hypothesis, there was no difference between how well fat was tolerated by patients who had undergone a right- or a left-sided resection.

Colorectal cancer survivors are often encouraged to follow lifestyle recommendations with potential beneficial effects on general health and recurrence of the disease [19] without recognizing that the advice may negatively affect bowel symptoms like diarrhea and bloating. They are recommended to eat diets high in vegetables, fruits, whole grains, chicken,

Table 2. Self-reported effects of dietary items on bowel symptoms.

Dietary adjustments/food categories	All ($N = 831$)	Cancer localization: Right colon ($N = 461$)	Cancer localization: Left colon ($N = 370$)	*p*-value
Are there any food categories/items that improve or worsen your bowel function?				
Yes, *n* (%)	267 (32)	163 (35)	104 (28)	0.078
No, *n* (%)	323 (39)	173 (38)	150 (41)	
Don't know, *n* (%)	241 (29)	125 (27)	116 (31)	
Do vegetables (e.g., cabbage and onions) improve or worsen your bowel function?				
Improve, *n* (%)	166 (21)	93 (21)	73 (21)	0.975
Worsen, *n* (%)	90 (11)	49 (11)	41 (12)	
No impact, *n* (%)	534 (68)	295 (68)	239 (67)	
Do fruits (e.g., apples and pears) improve or worsen your bowel function?				
Improve *n* (%)	117 (15)	65 (15)	52 (15)	0.433
Worsen *n* (%)	48 (6)	31 (7)	17 (5)	
No impact *n* (%)	622 (79)	341 (78)	281 (80)	
Do dairy products (e.g., milk, yoghurt and cream) improve or worsen your bowel function				
Improve *n* (%)	95 (12)	60 (14)	35 (10)	0.273
Worsen *n* (%)	54 (7)	31 (7)	23 (7)	
No impact *n* (%)	629 (81)	342 (79)	287 (83)	
Does meat (e.g., read meat) improve or worsen your bowel function?				
Improve *n* (%)	24 (3)	18 (4)	6 (2)	0.111
Worsen *n* (%)	99 (13)	58 (14)	41 (12)	
No impact *n* (%)	650 (84)	354 (82)	296 (86)	
Do fats and fatty foods improve or worsen your bowel function?				
Improve *n* (%)	14 (2)	9 (2)	5 (1)	0.399
Worsen *n* (%)	193 (25)	114 (26)	79 (23)	
No impact *n* (%)	569 (73)	308 (72)	261 (76)	
Do spices (e.g., spicy food or spices in general) improve or worsen your bowel function				
Improve *n* (%)	33 (4)	22 (5)	11 (3)	0.084
Worsen *n* (%)	149 (19)	92 (21)	57 (17)	
No impact *n* (%)	598 (77)	320 (74)	278 (80)	
Do carbonated drinks (e.g., soft drinks, sparkling water, beer) improve or worsen your bowel function				
Improve *n* (%)	27 (3)	18 (4)	9 (5)	0.475
Worsen *n* (%)	56 (7)	31 (7)	25 (7)	
No impact *n* (%)				
Do coffee and tea improve or worsen your bowel function				
Improve *n* (%)	47 (6)	23 (5)	24 (7)	0.066
Worsen *n* (%)	34 (4)	25 (6)	9 (3)	
No impact *n* (%)	702 (90)	386 (89)	316 (90)	
Do sweets (e.g., sugar and sweets) improve or worsen your bowel function				
Improve *n* (%)	7 (1)	5 (1)	2 (0.6)	0.706
Worsen *n* (%)	101 (13)	57 (13)	44 (13)	
No impact *n* (%)	666 (86)	367 (85)	299 (87)	
Does alcohol (e.g., beer, wine or liquor) improve or worsen your bowel function				
Improve *n* (%)	17 (2)	9 (2)	8 (2)	0.897
Worsen *n* (%)	83 (11)	48 (11)	35 (10)	
No impact *n* (%)	670 (87)	370 (87)	300 (87)	
Did you during your treatment for cancer receive any dietary advice or recommendations				
Yes *n* (%)	198 (24)	114 (25)	84 (23)	0.181
No *n* (%)	546 (66)	310 (67)	236 (66)	
Don't know *n* (%)	86 (10)	40 (9)	46 (13)	
Did you since your treatment for cancer seek information about diet or nutrition				
Yes *n* (%)	221 (27)	115 (25)	106 (29)	0.323
No *n* (%)	593 (71)	334 (73)	259 (70)	
Don't know *n* (%)	16 (2)	11 (2)	5 (1)	

Data are presented as numbers (%). Fischer's exact test.
Results are given as numbers and (percentage).

Table 3. Supplements and Medication for managing Bowel symptoms.

	Total 831 (100)	Cancer localization: Right colon $n = 460$	Cancer localization: Left colon $n = 371$	*p*-value
Bulking agents, yes, *n* (%)	132 (16)	62 (14)	70 (19)	0.036*
Bulking agents, no, *n* (%)	697 (84)	397 (86)	300 (81)	
Anti-diarrheal, yes, *n* (%)	53 (6)	35 (8)	18 (5)	0.117
Anti-diarrheal, no, *n* (%)	778 (94)	425 (92)	353 (95)	
Fiber supplements, yes, *n* (%)	236 (29)	139 (30)	97 (26)	0.245
Fiber supplements, no, *n* (%)	590 (71)	320 (70)	270 (74)	

Data are presented as numbers (%). Fischer's exact test.
*$p < 0.05$ Right colon compared to the left colon.

and fish and less refined sugars, fats, and red or processed meat. In a cross-sectional study, including survivors of colo-rectal cancer, a diet with a high intake of fruits and vegetables was associated with better quality of life, but no information on bowel symptoms was included [28]. In our population, some reported that vegetables and fruits caused discomfort while others found them helpful. Sun et al. found that many CC survivors make dietary adjustments to control their bowel function [10], and in accordance with our data the food items most often avoided were fat, spices and dairy products. They also found that bowel symptoms were

Table 4. Dietary advice is given by healthcare professionals.

Dietary advice given by healthcare professionals ($n = 44$)	Cancer localization and symptoms		
	Right-sided resection with diarrhea	Left-sided resection with diarrhea	Left-sided resection with bloating
Vegetables (e.g., cabbage and onions)			
Recommend *n* (%)	9 (21)	9 (21)	3 (7)
Avoid *n* (%)	14 (32)	13 (30)	28 (64)
Fruits (e.g., apples and pears)			
Recommend *n* (%)	2 (5)	2 (5)	1 (2)
Avoid *n* (%)	17 (39)	15 (34)	12 (27)
Sweets			
Recommend *n* (%)	1 (2)	1 (2)	1 (2)
Avoid *n* (%)	19 (43)	18 (41)	21 (48)
Spices (e.g., spicy food or spices in general)			
Recommend *n* (%)	0 (0)	0 (0)	0 (0)
Avoid *n* (%)	11 (25)	14 (32)	14 (32)
Red meat			
Recommend *n* (%)	0 (0)	0 (0)	0 (0)
Avoid *n* (%)	10 (23)	11 (25)	7 (16)
Fats and fatty foods			
Recommend *n* (%)	0 (0)	0 (0)	0 (0)
Avoid *n* (%)	17 (39)	12 (27)	5 (11)
Dairy products (e.g., milk, yoghurt and cream)			
Recommend *n* (%)	3 (7)	3 (7)	3 (7)
Avoid *n* (%)	5 (11)	3 (7)	7 (16)
Alcohol (e.g., beer, wine or liquor)			
Recommend *n* (%)	0 (0)	0 (0)	0 (0)
Avoid *n* (%)	17 (39)	15 (34)	7 (16)
Coffee and tea			
Recommend *n* (%)	0 (0)	0 (0)	0 (0)
Avoid *n* (%)	9 (21)	12 (27)	8 (18)

Data are presented as numbers (%).

Table 5. Medication prescribed against bowel symptoms.

	Cancer localization	
	Right colon	Left colon
Bile acid sequestrants, surgeons only, *n* (%)	9 (53)	1 (6)
Anti-diarrheal, surgeons only, *n* (%)	10 (59)	11 (65)
Fiber supplements, healthcare professionals all, *n* (%)	41 (93)	42 (95)

Data are presented as numbers (%).

alleviated by adequate fluid, vegetables, rice, soft foods and alcohol. Surprisingly, none of the two studies found any difference depending on whether a right- or a left-sided resection had been performed.

The perception of individual food items affecting bowel function can be difficult to interpret since a variety of different dishes include combinations of these. Moreover, no dietary questionnaire focusing on gastrointestinal late adverse effects has been validated among colorectal cancer survivors. Food frequency questionnaires are commonly used to assess dietary intake e.g., in epidemiological studies and several studies have previously looked at the dietary intake and risk of colorectal cancer or colorectal cancer recurrence. One study has evaluated the validity of dietary intake by Food Frequency Questionnaire in colorectal cancer survivors as opposed to a 7-day dietary record [29]. The questionnaire used in the present study was inspired by the study of Sun et al. [10].

Nearly all healthcare professionals stated that they and/or their unit gave advice about diet and bowel function to CC survivors. In contrast, only 24% of patients remembered having received such information during treatment or follow-up. Thus, 27% had sought such information from other sources. Since the healthcare professionals participating in the study were from other units than the patients included, the striking difference in information given or perceived could potentially reflect different practices at various hospital departments. We do however find this explanation highly unlikely as we included patients and healthcare professionals from several hospitals throughout Denmark.

In general, patients seek information about diet, cancer and bowel symptoms from different sources e.g., from patients' cancer societies [30] or other media. Such information may have affected the respondent's perception of diet and bowel symptoms.

In general, cancer survivors are motivated to change diet if relevant, but most dietary adjustments are made on the patient's own initiative and based on trial and error [10,31–33]. In our cohort, only one in four remembered having received any information on diet and bowel function from healthcare professionals. In accordance with previous studies, higher age was associated with lack of information while younger age and female gender were associated with self-sought information [34–37]. The questions on diet were part of a larger questionnaire sent to colon cancer survivors 3, 12, 24 and 36 months after the end of treatment. For patients with rectum cancer, bowel symptoms tend to become less severe within the first year after surgery. For colon cancer, the survivor's time before bowel function becomes relatively stable maybe even longer. As most colon cancer survivors will live for several years, we aimed to study bowel function when it was as stable as possible. Therefore, we only included data from the last questionnaire received.

Studying the development of symptoms or changes in diet over time was beyond the scope of the present study.

In contrast to the patient's experience, almost all healthcare professionals stated that CC survivors at their unit received advice about diet and fiber supplements. Whether such information is less consistently given than stated by the healthcare professionals or the patients forget it among the other information given during their course of the disease cannot be answered from our data. Most healthcare professionals recommended the avoidance of sweets, fruits and alcohol while patients mainly perceived that fat and spicy food caused symptoms. Based on these findings we recommend that written information about diet after colectomy is provided.

Patients having undergone right-sided resection mainly suffer from increased frequency of defecation and loose stools, while patients having undergone left-sided resection may have fragmentation and a feeling of obstructed defecation [5,6,8,13,14]. The underlying pathophysiology behind colorectal dysfunction in CC survivors remains incompletely understood and several factors coexist. The main causes appear to be a small intestinal bacterial overgrowth and bile-acid malabsorption, but excessive fiber intake and pancreatic insufficiency have also been reported [38]. Phillips et al. found that 40% of patients surviving right-sided CC had bile acid malabsorption [39]. Treatment of bile acid diarrhea includes bile acid sequestrants [12,13,40,41] and reduced dietary intake of fat [12–14,40,42]. In our study, 39 (8.5%) patients with right-sided resection and 21 (6%) patients with a left-sided resection reported poor or very poor bowel function. This is less than in the study by the study by Bulchi et al. reported that 20.6% of patients with a right-sided resection and 15.7% of those with a left-sided resection had bowel dysfunction [43].

In total 155 (19%) of our patients reported that bowel symptoms affected their quality of life. This number is very close to previous reports [6,44]. A Danish normative study showed that bowel symptoms corresponding to LARS are common in the general population, especially in the age group 50–79 years [45]. Though these results are not directly comparable to ours, it demonstrates that bowel dysfunction is common both among colon cancer survivors and in the general population. We expected that the differences in symptoms and the underlying pathophysiology among patients with right-sided and left-sided resections would be reflected in dietary items perceived to cause symptoms. This was not the case. Whether this reflects that diet has minor effects on symptoms or the effects of diet are too complex to be evaluated in a simple questionnaire remains obscure.

In our study, only half of the responding doctors would prescribe bile acid sequestrants to patients with diarrhea after right-sided resections and only 39% of healthcare professionals would recommend the avoidance of fat. Hence, more focus on these common complications is needed and education is recommended.

Attention to gastrointestinal symptoms and a specific nutritional diagnosis improve the treatment of patients [4,38]. Unfortunately, only 13 out of 51 guidelines for treatment and follow-up of CC have recommendations for managing late sequelae. Most recommendations included very vague statements about a healthy lifestyle, diet, and physical activity. Only a few guidelines include treatment guidelines for fecal incontinence and chronic diarrhea [18]. The American Cancer Society Colorectal Cancer Survivorship Care Guidelines [19], The National Comprehensive Cancer Network [46], The European Society for Medical Oncology [47] and National Institute for Health and Care Excellence (NICE) [48] typically recommend anti-diarrheal medications, bulk-forming agents, pelvic floor rehabilitation and protective undergarments [19,47,49]. Persistent symptoms and chronic bowel problems may necessitate referral to gastroenterologists and if additional diet support is needed, survivors should be referred to a specialized dietitian [11,12,19,38,47]. We propose that dietary advice and intervention should be considered much earlier in the rehabilitation of CC survivors.

Fiber supplements or Loperamide are common first-line treatments for chronic diarrhea [19], but the evidence for the use of fiber supplements in CC survivors is scarce. Almost all healthcare professionals in our study recommend fiber supplements (psyllium) to CC survivors with gastrointestinal symptoms, but less than one-third of patients actually took fiber supplements.

The present study has limitations. The median follow-up was only two years from the time of surgery and the design was cross-sectional. This makes it impossible to draw firm conclusions on correlations between dietary items and gastrointestinal symptoms. Another limitation is the lack of a validated questionnaire on diet. A control group of healthy volunteers without previous colorectal surgery would have strengthened our study. We did not collect data on socioeconomic status or the ethnic composition of our study population. Denmark is, however, a very homogeneous society with a healthcare system almost entirely funded by the government. Hence, the population treated very much reflects the entire population of colon cancer patients and the vast majority would be Caucasian.

In conclusion, one-third of CC survivors reported that some food items, especially fat and spices have a negative impact on their bowel function. We found a significant difference between the large proportion of healthcare professionals reporting giving dietary advice to CC survivors and the few patients recalling such advice. There is an unmet need for further recognition of the role of diet in CC rehabilitation and for intervention studies of treatment principles.

Author contributions

JF, SL, PC, ABB, OTU, MBL, AMD, PF: Concept and design of the study, electronic data collection from their respective units, important intellectual contribution and to the data analysis and approval of the final version submitted.

MB: Concept and design of the study, design of the questionnaires used, data analysis, written the first version of the manuscript and revised it according to comments from the authors.

TJ: Concept and design of the study, design of the questionnaires used, data analysis, critical comments to the final version of the manuscript.

KK: Concept and design of the study, design of the questionnaires used, data analysis, revised first the first version of the manuscript, guarantor of the manuscript.

Disclosure statement

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