



The determinants of reduced dietary intake in hospitalised colorectal cancer patients

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Abstract

Purpose Patients with colorectal cancer (CRC) often experience malnutrition and weight loss, largely resulting from reduced dietary intake. The aim of this study was to identify determinants of reduced dietary intake in order to facilitate early recognition of malnutrition and optimise nutritional treatment.

Methods Data from nutritionDay, an international 1-day survey investigating patient, disease and food profiles, were used. To identify determinants of dietary intake, defined as normal vs. reduced in the last week, univariate and multivariate logistic regressions were performed.

Results Of 1131 hospitalised CRC patients, 54% reported reduced dietary intake. Patient- and disease-related characteristics significantly associated with reduced dietary intake were female gender (odds ratio (OR) 1.38), cancer stage III (OR 1.52) or IV (OR 1.70) vs. I, performance status 2 (OR 1.56), 3 (OR 2.37) or 4 (OR 4.15) vs. 0, duration since hospital admission of ≥ 4 days (OR 4–7 days, 1.91; 8–21 days, 1.97; > 21 days, 1.92) vs. < 4 days, and unintentional weight loss (OR 2.56). Additionally, higher symptom scores of pain, weakness, depression, tiredness and lack of appetite were associated with reduced intake.

Conclusions Patient- and disease-related determinants for reduced dietary intake were being female, higher cancer stage, worse performance status, duration since hospital admission ≥ 4 days and unintentional weight loss. Furthermore, multiple symptoms were associated with a reduced dietary intake. Future trials should assess whether early recognition of patients at risk of malnutrition and the combination of treating symptoms and dietary advice result in improved intake and treatment-related outcomes.

Keywords Determinants · Dietary intake · Colorectal cancer · Malnutrition

Abbreviations

CRC Colorectal cancer

Introduction

Colorectal cancer (CRC) is the third most common cancer in the world, representing nearly 10% of the global cancer incidence and 8% of all cancer deaths [11, 30]. Patients with CRC

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often experience undesirable disease-related symptoms such as malnutrition and weight loss. The prevalence of malnutrition in CRC patients varies from 29 to 60% [9, 13, 20, 24–26, 33] and is suggested to be even higher during hospital stay [18, 31, 33]. Previous studies have shown that malnutrition is associated with worse clinical outcomes for this patient group. A poor nutritional status in preoperative patients negatively affects postoperative outcome and is predictive of increased length of hospital stay [17, 29], whilst for patients receiving chemotherapy, malnutrition is associated with lower treatment tolerance and reduced survival [1, 3, 28].

Malnutrition in cancer patients can be a consequence of both metabolic changes and reduced dietary intake [32]. Whilst treatment of metabolic changes mainly concerns treatment of the underlying cancer, reduced dietary intake can often be avoided. Reduced dietary intake is the main driver in the development of malnutrition; thus, early detection of a reduced intake and intervention aiming to increase intake are essential in the prevention of malnutrition [2]. In order to identify patients with or at risk of a reduced dietary intake, determinants of a reduced dietary intake should be established.

The current literature suggests that particular patient- and disease-related characteristics are associated with poorer dietary intake. Characteristics of cancer patients associated with poorer dietary intake include being female and/or elderly, having prior surgery or chemotherapy, receiving more than one treatment mode or having a more progressive disease [9, 15, 23, 24, 27, 33]. In addition, emerging literature speculates that a low body mass index (BMI), a worse performance status and being unmarried may also increase the chances of poorer intakes [9, 29]. The observed reduction in food intakes is thought to be explained by unwanted symptoms and side effects of treatment for CRC, which often includes chemo- and/or radiotherapy. Whilst loss of appetite is accepted as the main driver for lower dietary intakes, cancer treatments can also induce severe nausea, vomiting and diarrhea that can lead to the development of food aversions, and mucositis that can distort ability to taste [5, 8, 12, 21, 24]. Additional treatment-induced symptoms such as fatigue, depression and pain and also tumor-induced symptoms such as cachexia, bloating and early satiety are similarly suggested to play a role in influencing dietary intakes in this patient group [7, 9, 10, 12, 14].

Although some determinants of reduced dietary intake in CRC patients are suggested in the current literature, they are not well elucidated as study protocols often include several cancer types. Furthermore, it is not known to what extent the presence of disease-related symptoms are related to reduce dietary intake. These symptoms may also have to be taken into account in CRC patients with an indication for nutritional intervention. The aim of this study was to evaluate determinants that are associated with reduced dietary intake in

hospitalised CRC patients to enable easier recognition of patients at risk of malnutrition and improve interventions to prevent malnutrition-related interurrences.

Materials and methods

Study design and patients

This study is based on data from nutritionDay surveys taken between 2012 and 2015. The nutritionDay is a 1-day cross-sectional audit investigating nutritional status in hospitalised patients worldwide. Spanning 62 countries, the nutritionDay database provides information on food intake, patient characteristics, disease profile and symptoms. The nutritionDay survey has been designed so that data can be collected by local caregivers and patients using four questionnaires. A detailed description of the study design and its main outcomes has been published [16]. The nutritionDay survey co-ordinating centre in Vienna received ethical approval for multicentre data collection, and local ethics approval was obtained as appropriate. All patients received verbal and written study information before giving informed consent. For the current study, patients with CRC were selected from the nutritionDay database ($n = 1300$). Patients were excluded from the analyses if data for dietary intake were missing ($n = 137$) or if patients were in a terminal stage of their disease ($n = 32$) resulting in a total of 1131 included patients.

Data collection and definitions

The primary outcome in this study was dietary intake during the week preceding nutritionDay. This was subjectively assessed with the question ‘How well have you eaten during the last week?’ with the following response options: ‘normal’, ‘a bit less than normal’, ‘less than half of normal’ and ‘less than quarter to nearly nothing’. For the purpose of this study, dietary intake was dichotomised as follows: normal vs. a bit less, half or less.

To determine which variables were associated with dietary intake (normal vs. less than normal), variables were classified as patient and disease-related characteristics or as symptom scores. The patient- and disease-related characteristics age, sex, cancer stage, therapy situation, therapy goal, comorbidities, duration since hospital admission and body mass index (BMI) were recorded by the medical staff. Therapy situation was categorised into seven groups: diagnosis, systemic treatment (chemotherapy and targeted therapy), surgery, radiotherapy, complications (cancer- or therapy-related), palliative and multiple. Therapy goal was dichotomised as curative vs. palliative. The following options were available to the medical staff for reporting comorbidities: diabetes, stroke, chronic obstructive pulmonary disease, myocardial infarction, cardiac

Table 1 Patient- and disease-related characteristics

	Total population	Dietary intake in the past week	
		Normal	Less than normal
Age (years)	65 ± 13	516 (46%)	615 (54%)
Sex		64 ± 13	66 ± 13
Male	626 (56%)	305 (49%)	321 (51%)
Female	500 (44%)	208 (42%)	292 (58%)
Cancer stage			
Carcinoma in situ/I	249 (24%)	133 (53%)	116 (47%)
II	180 (18%)	92 (51%)	88 (49%)
III	177 (17%)	76 (43%)	101 (57%)
IV	418 (41%)	174 (42%)	244 (58%)
Therapy situation			
Diagnosis	89 (8%)	45 (51%)	44 (49%)
Surgery	346 (32%)	161 (47%)	185 (53%)
Radiotherapy	36 (3%)	16 (44%)	20 (56%)
Systemic treatment	305 (28%)	160 (53%)	145 (47%)
Treatment of complications	76 (7%)	29 (38%)	47 (62%)
Palliative care	96 (9%)	28 (29%)	68 (71%)
Multiple	141 (13%)	52 (37%)	89 (63%)
Therapy goal			
Curative	684 (62%)	330 (48%)	354 (52%)
Palliative	420 (38%)	170 (41%)	250 (59%)
Duration since hospital admission (days)			
< 4	379 (34%)	225 (59%)	154 (41%)
4–7	232 (21%)	95 (41%)	137 (59%)
8–21	341 (30%)	129 (38%)	212 (62%)
> 22	169 (15%)	66 (39%)	103 (61%)
Comorbidity			
None	478 (42%)	215 (45%)	263 (55%)
One or more	653 (58%)	301 (46%)	352 (54%)
Number of drugs per day			
0	132 (13%)	75 (57%)	57 (43%)
1–2	227 (22%)	112 (49%)	115 (51%)
3–5	322 (31%)	150 (47%)	172 (54%)
> 5	353 (34%)	138 (39%)	215 (61%)
Body mass index (kg/m ²)			
< 18.5	100 (9%)	32 (32%)	68 (68%)
18.5–25	516 (48%)	250 (48%)	266 (52%)
25–30	324 (30%)	154 (48%)	170 (52%)
30–35	107 (10%)	51 (48%)	56 (52%)
> 35	31 (3%)	16 (52%)	15 (48%)
Unintentional weight loss in last 3 months			
No	387 (36%)	238 (62%)	149 (38%)
Yes	683 (64%)	251 (37%)	432 (63%)
Self-reported performance score			
0	193 (18%)	124 (64%)	69 (36%)
1	230 (22%)	117 (51%)	113 (49%)
2	294 (28%)	140 (48%)	154 (53%)
3	179 (17%)	65 (36%)	114 (64%)
4	166 (16%)	37 (22%)	129 (78%)

Data are presented as number (%) or mean ± standard deviation

insufficiency or others. For this study, comorbidity was categorised as none vs. one or more. Duration since admission to hospital was categorised based on the association with dietary intake with separate categories for longer duration since hospital admission, resulting in four groups: < 4, 4–7, 8–21 and > 22 days. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres and classified into six groups (underweight, < 18.5 kg/m²; normal weight, 18.5–25 kg/m²; overweight, 25–30 kg/m²;

obesity class I, 30–35 kg/m²; obesity class II, > 30 kg/m²). Unintentional weight loss in the past 3 months was evaluated by the patient as yes or no. Self-reported performance score was assessed following the guidelines of the Eastern Cooperative Oncology Group (ECOG) [22], with the following question and options: which of the following activities can you perform at the maximum? The categories are fully active (0), able to carry out light activities (1), able to carry out self-care (2), able to carry out limited self-care (3) or confined to

Table 2 Patient- and disease-related determinants of dietary intake less than normal

	N	Univariate		Multivariate model 1		Multivariate model 2	
		OR [95% CI]	<i>p</i>	OR [95% CI]	<i>p</i>	OR [95% CI]	<i>p</i>
Sex (male = reference)	1126	1.33 [1.05, 1.69]	0.017	1.38 [1.06, 1.79]	0.017	1.38 [1.06, 1.78]	0.015
Age (years)			0.151				
< 30	10	2.28 [0.58, 8.96]	0.239				
30–39	33	0.81 [0.40, 1.67]	0.574				
40–49	107	0.89 [0.58, 1.38]	0.052				
50–59	192	1.43 [1.00, 2.04]	0.597				
60–69	336	Reference					
70–79	300	1.16 [0.85, 1.59]	0.346				
80–89	133	1.57 [1.04, 2.37]	0.031				
90–99	17	1.40 [0.52, 3.75]	0.510				
Cancer stage			0.008		0.010		0.007
Carcinoma in situ/stage I	249	Reference		Reference		Reference	
II	180	1.10 [0.75, 1.61]	0.637	1.09 [0.71, 1.66]	0.697	1.06 [0.70, 1.60]	0.781
III	177	1.52 [1.03, 2.25]	0.033	1.45 [0.94, 2.24]	0.092	1.52 [1.00, 2.30]	0.050
IV	418	1.61 [1.17, 2.21]	0.003	1.62 [1.09, 2.41]	0.018	1.70 [1.20, 2.40]	0.003
Missing	107	1.85 [1.16, 2.93]	0.009	2.28 [1.34, 3.86]	0.002	1.90 [1.16, 3.11]	0.011
Therapy situation			0.001		0.380		
Diagnosis	89	Reference		Reference			
Surgery	346	1.18 [0.74, 1.87]	0.497	1.12 [0.67, 1.89]	0.659		
Radiotherapy	36	1.28 [0.59, 2.78]	0.536	1.11 [0.47, 2.63]	0.815		
Complications	76	1.66 [0.89, 3.09]	0.111	1.18 [0.60, 2.36]	0.629		
Palliative	96	2.48 [1.36, 4.55]	0.003	1.70 [0.84, 3.45]	0.140		
Multiple	141	1.75 [1.02, 3.00]	0.041	1.48 [0.81, 2.71]	0.203		
Systemic treatment	305	0.93 [0.58, 1.49]	0.753	1.05 [0.61, 1.80]	0.868		
Missing	42	0.70 [0.33, 1.46]	0.338	0.63 [0.28, 1.45]	0.280		
Therapy goal			0.015		0.265		
Curative	684	Reference		Reference			
Palliative	420	1.37 [1.07, 1.75]	0.012	0.96 [0.69, 1.34]	0.817		
Missing	27	0.64 [0.29, 1.40]	0.265	0.48 [0.19, 1.16]	0.103		
Duration since admission (days)			< 0.001		0.001		< 0.001
< 4	379	Reference		Reference		Reference	
4–7	232	2.11 [1.51, 2.94]	< 0.001	1.83 [1.26, 2.65]	0.001	1.91 [1.34, 2.73]	< 0.001
8–21	341	2.40 [1.78, 3.24]	< 0.001	1.96 [1.38, 2.78]	< 0.001	1.97 [1.42, 2.73]	< 0.001
> 21	169	2.28 [1.57, 3.30]	< 0.001	1.83 [1.19, 2.82]	0.006	1.92 [1.28, 2.88]	0.002
Comorbidity (no = reference)	1131	0.96 [0.75, 1.21]	0.710				
Number of drugs per day			0.006		0.504		
None	132	Reference		Reference			
1–2	227	1.35 [0.88, 2.08]	0.172	1.44 [0.90, 2.32]	0.131		
3–5	322	1.51 [1.00, 2.27]	0.048	1.33 [0.85, 2.10]	0.211		
> 5	353	2.05 [1.37, 3.08]	0.001	1.42 [0.90, 2.32]	0.128		
Missing	97	1.80 [1.06, 3.05]	0.030	1.11 [0.61, 2.01]	0.734		
BMI			0.002		0.372		
< 18.5	100	2.00 [1.27, 3.15]	0.003	1.48 [0.90, 2.43]	0.121		
18–25	516	Reference	0.795	Reference			
25–30	324	1.04 [0.79, 1.37]	0.882	1.17 [0.86, 1.59]	0.326		
30–35	107	1.03 [0.68, 1.57]	0.732	1.25 [0.79, 1.98]	0.345		
> 35	31	0.88 [0.43, 1.82]	0.001	0.88 [0.39, 2.00]	0.765		

Table 2 (continued)

	N	Univariate		Multivariate model 1		Multivariate model 2	
		OR [95% CI]	<i>p</i>	OR [95% CI]	<i>p</i>	OR [95% CI]	<i>p</i>
Missing	53	2.89 [1.51, 5.54]	0.481	1.82 [0.88, 3.79]	0.108		
Unintentional weight loss			<i>< 0.001</i>		<i>< 0.001</i>		<i>< 0.001</i>
No	387	Reference		Reference		Reference	
Yes	683	2.75 [2.13, 3.56]	<i>< 0.001</i>	2.52 [1.90, 3.36]	<i>< 0.001</i>	2.56 [1.94, 3.37]	<i>< 0.001</i>
Missing	61	2.01 [1.17, 3.47]	0.012	1.55 [0.85, 2.86]	0.151	1.54 [0.86, 2.76]	0.145
Self-reported performance score			<i>< 0.001</i>		<i>< 0.001</i>		<i>< 0.001</i>
0	193	Reference		Reference		Reference	
1	230	1.74 [1.17, 2.57]	0.006	1.26 [0.82, 1.93]	0.290	1.37 [0.90, 2.08]	0.143
2	294	1.98 [1.36, 2.87]	<i>< 0.001</i>	1.44 [0.96, 2.16]	0.079	1.56 [1.04, 2.32]	0.030
3	179	3.15 [2.06, 4.81]	<i>< 0.001</i>	2.13 [1.33, 3.41]	0.002	2.37 [1.50, 3.72]	<i>< 0.001</i>
4	166	6.27 [3.92, 10.02]	<i>< 0.001</i>	3.67 [2.17, 6.20]	<i>< 0.001</i>	4.15 [2.51, 6.86]	<i>< 0.001</i>
Missing	69	1.96 [1.12, 3.42]	0.018	1.56 [0.85, 2.86]	0.148	1.66 [0.93, 2.99]	0.089

Data are presented as odds ratios (OR) with 95% confidence intervals (CI). Model 1 includes all characteristics with $p < 0.10$ in univariate analysis, $n = 1116$ and $R^2 = 0.203$. Model 2 includes characteristics with $p < 0.05$ after backward regression, $n = 1116$ and $R^2 = 0.182$. Italicized data is significant at ($p < 0.05$)

bed or chair (4). The number of drugs ingested daily was indicated by the patient and categorised into four groups: 0, 1–2, 3–5 and > 5 .

The symptom scores of had pain, felt weak, felt depressed, felt tired and lacked appetite during the past week were reported by the patient with questions concerning the last week. Symptoms could be rated on a 4-point Likert scale: not at all, a little, quite a bit and very much.

Statistics

Statistical analyses were performed using SPSS v 23 (IBM Corp., USA). Descriptive data are presented as mean \pm standard deviation or as total frequencies and proportions. Patient- and disease-related characteristics and symptom scores were analysed separately. This was done because the symptoms are expected to be caused by patient- and disease-related characteristics and are potentially mediating the association with dietary intake.

First, univariate logistic regressions were done to determine variables associated with reduced dietary intake. On all variables significantly associated with a reduced dietary intake in univariate analysis, correlation coefficient analyses were performed. For correlation coefficients, all missing values were excluded. Depending on the type of variables, Spearman's (two ordinal), phi (two binary), Cramer's V (binary and categorical) or the Kruskal-Wallis (ordinal and nominal/binary) tests were performed. For any two variables that were strongly correlated ($b > 0.5$), a decision was made to exclude one of the variables from the subsequent multivariate analysis so that it did not disrupt the model. Next, all variables associated with reduced dietary intake in the univariate

logistic regression model were simultaneously entered into a multivariate logistic regression model (multivariate model 1), using $p < 0.10$ for entering into the model. Backward elimination was done until all variables in the multivariate model reached a significance of $p < 0.05$ (multivariate model 2). For all logistic regression analyses, 95% confidence intervals (CI) for odds ratios (OR) were reported.

Categories with more than ten missing values were considered as a separate group in logistic regression. If ten or less missing values existed for any variable, then patients with this missing value were excluded from that analysis. Two sensitivity analyses were performed by rerunning the backward regression for patient- and disease-related characteristics, one with dietary intake dichotomised into normal or a bit less vs. half or less and one without the variable 'self-reported performance score', because this variable concerned the audit day and may have changed in the preceding week. In addition, interactions between determinants for eating less than normal were checked. Model fit of the multivariate model was expressed as the Nagelkerke R^2 .

Results

Patient characteristics

Patient- and disease-related characteristics of all 1131 patients are shown in Table 1. The mean age was 65 ± 13 years (range 19–98) and 626 (56%) patients were male. Of all patients, 418 (41%) had cancer stage IV, 305 (28%) were receiving systemic treatment and 346 (32%) were admitted for surgery. Eating less than normal in the past week was reported by 615 (54%)

patients and unintentional weight loss in the past 3 months was reported by 683 (64%) patients.

Determinants of reduced dietary intake

Patient- and disease-related characteristics

The following patient- and disease-related characteristics were significantly associated with a reduced dietary intake in univariate analyses: female gender ($p = 0.017$), higher cancer stage ($p = 0.008$), lower self-reported performance score ($p < 0.001$), longer duration since hospital admission ($p < 0.001$), unintentional weight loss during the past 3 months ($p < 0.001$), lower BMI ($p = 0.002$), therapy situation ($p = 0.001$), palliative therapy goal ($p = 0.015$) and higher number of drugs ingested daily ($p = 0.006$) (Table 2). These variables were simultaneously entered into a multivariate logistic regression model with reduced dietary intake as outcome (Table 2—multivariate model 1, $n = 1116$, $R^2 = 0.203$). Backward regression resulted in a model including the variables sex ($p = 0.015$), cancer stage ($p = 0.007$), self-reported performance score ($p < 0.001$), duration since admission ($p < 0.001$) and unintentional weight loss ($p < 0.001$) (Table 2—multivariate model 2, $n = 1116$, $R^2 = 0.182$). Sensitivity analysis with dietary intake dichotomised into normal or a bit less vs. half or less resulted in a similar model ($n = 1116$, $R^2 = 0.216$). However, sex and cancer stage were not significant anymore, whilst BMI and therapy goal were. The results implied that patients with a BMI < 18.5 or $30\text{--}35$ vs. $> 18\text{--}25$ kg/m² and patients with a palliative vs. curative treatment have higher odds to eat substantially less than normal. Also sensitivity analysis by backward regression without the variable ‘self-reported performance score’ resulted in a model with the same significant determinants ($n = 1116$, $R^2 = 0.139$).

Symptoms

Patient-reported symptom scores in relation to dietary intake during the past week are shown in Table 3. The symptoms pain, weakness, depression, tiredness and lack of appetite experienced during the past week were all significantly associated with dietary intake during the past week ($p < 0.05$, Table 3). Because all of the symptom scores were highly correlated, multivariate regression was not performed.

Discussion

The present study shows that 54% of hospitalised colorectal cancer patients ate less than normal in the week preceding nutritionDay, a 1-day cross-sectional audit investigating

nutritional status in hospitalised patients worldwide. Being female, higher cancer stage, worse self-reported performance score, longer duration of hospital stay and unintentional weight loss were significantly associated with reduced dietary intake and can therefore be used to identify patients at risk of malnutrition. In addition, the symptoms having pain, lacking appetite and feeling weak, tired and depressed were significantly associated with reduced dietary intake. Since patient- and disease-related characteristics cannot always be influenced, nutritional interventions may benefit from alleviating these negative symptoms reported by patients to further optimise nutritional status.

These predicting characteristics have to some degree been identified in previous literature, yet the low patient numbers, the different cancer types and the use of different definitions of malnutrition made it difficult to apply these findings in clinical practice. Previous studies have demonstrated that being female, a higher ECOG performance status and weight loss were significantly associated with higher nutritional risk as indicated by the PG-SGA [9, 18]; however, one study included various cancer types and another had poor questionnaire compliance. Associations between cancer stage and malnutrition were found in two studies using different definitions of malnutrition [23, 33], as well as associations between performance status and reduced dietary intake were found [3]. Moreover, associations between increased length of hospital stay and nutritional risk have been reported in colorectal cancer patients using the NRS-2002 tool [20] and associations with nutritional status have been found in gastrointestinal cancer patients using the SGA [34]. Thereby, the present study confirms what was already known from previous studies. However, the present study, with data derived from the largest ongoing survey of nutrition in hospitalised patients, enriches the current literature with explicit results exclusively investigating colorectal cancer patients with dietary intake as the primary outcome. This provides a complete overview of the determinants of dietary intake in this patient cohort and makes comparisons between variables now possible due to standardised data collection.

The present multivariate analysis shows clear relationships between the increases in cancer stage and performance status and the increases in outcome odds for reduced dietary intake, with a high risk for patients with a performance score of 3 or 4 and patients with stage IV cancer. These findings thereby underpin the importance of considering patients’ performance score and cancer stage when assessing the likelihood of reduced dietary intake. There were little differences in the odds ratios for days since hospital admission when compared to the reference category of < 4 days. The increased odds for eating less than normal when admitted to the hospital 4–7 days may partly be due to the fact that nutritionDay is normally on a Thursday and therefore, this category included patients admitted to the hospital in the weekend. Because being admitted to

Table 3 Self-reported symptom scores and association with dietary intake during the week preceding nutritionDay

	<i>N</i>	Dietary intake during the past week		Determinants for eating less than normal (univariate)	
		Normal	Less than normal	OR [95% CI]	<i>p</i>
Had pain					< 0.001
Not at all	380	217 (57%)	163 (43%)	Reference	
A little bit	318	150 (47%)	168 (53%)	1.49 [1.01, 2.01]	
Quite a bit	228	78 (34%)	150 (66%)	2.56 [1.82, 3.60]	
Very much	148	36 (24%)	112 (76%)	4.14 [2.70, 6.35]	
Missing	57	35 (61%)	22 (39%)	0.84 [0.47, 1.48]	
Felt weak					< 0.001
Not at all	284	186 (65%)	98 (35%)	Reference	
A little bit	295	159 (54%)	136 (46%)	1.62 [1.16, 2.27]	
Quite a bit	271	86 (32%)	185 (68%)	4.08 [2.87, 5.82]	
Very much	217	51 (24%)	166 (76%)	6.18 [4.15, 9.20]	
Missing	64	34 (53%)	30 (47%)	1.68 [0.97, 2.90]	
Felt depressed					< 0.001
Not at all	462	259 (56%)	203 (44%)	Reference	
A little bit	304	129 (42%)	175 (58%)	1.73 [1.29, 2.32]	
Quite a bit	170	49 (29%)	121 (71%)	3.15 [2.16, 4.60]	
Very much	125	41 (33%)	84 (67%)	2.61 [1.72, 3.96]	
Missing	70	38 (54%)	32 (46%)	1.07 [0.65, 1.78]	
Felt tired					< 0.001
Not at all	281	180 (64%)	101 (36%)	Reference	
A little bit	339	168 (50%)	171 (50%)	1.91 [1.31, 2.51]	
Quite a bit	246	78 (32%)	168 (68%)	3.84 [2.67, 5.52]	
Very much	194	49 (25%)	145 (75%)	5.27 [3.52, 7.91]	
Missing	71	41 (58%)	30 (42%)	1.30 [0.77, 2.22]	
Lacked appetite					< 0.001
Not at all	448	326 (73%)	122 (27%)	Reference	
A little bit	250	89 (36%)	161 (64%)	1.49 [1.01, 2.01]	
Quite a bit	177	35 (20%)	142 (80%)	2.56 [1.82, 3.60]	
Very much	184	23 (13%)	161 (87%)	4.14 [2.70, 6.35]	
Missing	72	43 (60%)	29 (40%)	0.84 [0.47, 1.48]	

Data are presented as number (%) or odds ratios (OR) with 95% confidence intervals (CI). Italicized data is significant at ($p < 0.05$)

the hospital in the weekend is usually not planned, these likely are unplanned hospital admissions and may include patients in poorer condition than the patients being admitted at weekdays. In addition, patients admitted to the hospital for < 4 days still ate the majority of their meals at home, potentially resulting in a larger number of normal dietary intakes. The fact that there were minimal differences between 8–21 and > 22 days indicates that being admitted for a longer period of time (≥ 8 days) results in higher odds for eating less than normal, regardless of the number of days. Patients in these categories may also be in a poorer condition than patients being admitted < 4 days.

Unintentional weight loss has previously been identified as a strong determinant of malnourishment [18] and here, we confirmed its association with reduced dietary intake. This simple

and easy to establish measure should be used to indicate patients who need dietary interventions, particularly for heavier patients who have lost weight but are missed by assessment tools that use ‘healthy’ threshold cut-offs, and in hospitals where full body composition measurements are not feasible. The comorbidity groups in this study were categorised into none vs. more than one due to the majority of patients falling into the ‘other’ comorbidity category and thus leaving small patient numbers in the specified categories. Perhaps with additional information, a more reliable test of the association between specific comorbidities and reduced dietary intake would be available.

In this study, higher symptom scores of pain, weakness, depression, tiredness and lack of appetite were significantly associated with eating less than normal during the past

week. This is in line with previous findings that pain and fatigue were correlated with low energy intake to a similar degree as loss of appetite in pancreatic cancer patients [6]. It is suggested that some symptoms (such as pain and weakness) directly contribute to reduced dietary intake whilst others (such as emotional states, for example, depression) act through driving appetite loss [27]. These findings have important implications considering the current weighted importance given to symptoms associated with reduced dietary intake. We suggest that, in addition to usual dietary practices, nutritional interventions should include identification and individual treatment of these symptoms to reduce the risk of inadequate dietary intake.

Assessing dietary intake in the past week as ‘normal’ or ‘less than normal’ as a primary outcome has its limitations. Preferably, actual dietary intake should be evaluated in order to estimate absolute energy and protein intake in comparison to a patient’s requirements. However, in the present study, dietary intake was assessed by asking the patient how well he/she had eaten. Although this does not provide information on absolute nutritional intake, it is an indication of dietary intake compared to what is normal for a patient. Eating less than normal has shown to be an important risk factor for malnutrition. Early identification of these patients at risk may be an indication to assess dietary intake into more detail and could provide the opportunity to prevent malnutrition with appropriate nutritional intervention [2, 4, 19].

Conclusion

Determinants for reduced dietary intake in colorectal cancer patients during hospital admission are being female, higher cancer stage, worse performance status, longer duration since admission and unintentional weight loss. In addition, the symptoms pain, weakness, depression, tiredness and lack of appetite are related to reduced dietary intake. In patients at risk of reduced dietary intake, assessment of dietary intake may be indicated to evaluate whether nutritional intervention is needed. Management of related symptoms should be included to achieve an optimal nutritional intake. Future trials should test the effectiveness of these intervention recommendations on dietary intake and body composition, in order to consequently achieve better treatment-related outcomes.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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