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Original Article

Colorectal cancer in Greenland

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ABSTRACT

INTRODUCTION. The aim of this paper was to present the incidence of colorectal cancer in Greenland and to compare treatment with Danish and international standards.

METHODS. This was a retrospective register study. The inclusion criterion was patients diagnosed with colorectal cancer in 2015-2020. Data were collected from patient records, including descriptions of CTs and data from the Danish Pathology Database. All information on survival and recurrence was updated until 15 May 2024.

RESULTS. The study included 237 patients with colorectal cancer in Greenland. Rectal cancer constituted 29%. The distribution percentages by UICC-stage I, II, III and IV were 11%, 18%, 34% and 36, respectively. Radicality for all patients was as follows: R0 59% for colon cancer and 55% for rectal cancer. The anastomotic leakage rate was 2.4% for colon cancer and 32% for rectal cancer. Ninety-day mortality was 2.5% for colon cancer and 2.1% for rectal cancer. Five-year-survival was 43% for colon cancer and 47% for rectal cancer, with no significant difference regarding sex or place of residence. For electively resected patients, the five-year survival rate was 49% for colon cancer and 68% for rectal cancer.

CONCLUSIONS. The studied Greenlandic population was younger and had a poorer survival rate than the Danish cohort. The incidence of colorectal cancer was equal.

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Data on healthcare and treatment for colorectal cancer (CRC) in Greenland are sparse. In 2025, the world's largest island had a population of 56,500 individuals, largely of Inuit origin [1].

Over recent decades, a notable increase in CRC incidence has been observed in Greenland, which may be attributed to dietary changes resulting from increased Western influence but also to improved detection methods and the increased availability of endoscopy services [2].

About 35% of Greenland's population lives in the capital, Nuuk. The rest live in rural areas where reaching the nearest hospital can take several hours by boat, helicopter or plane. This geographic challenge complicates diagnostic and treatment processes and is believed to contribute to higher mortality rates in Greenland than in the rest of the Danish Realm.

Patients diagnosed with stage I-III colon cancer are offered curative surgical resection. The surgical procedures for colon cancer are performed at Queen Ingrid's Hospital (QIH) in Nuuk. As a part of the Danish Realm, patients with rectal cancer are referred to Denmark for treatment, specifically at Hvidovre Hospital, Rigshospitalet, or Bispebjerg Hospital. All resected tissue is sent to the pathology department at Rigshospitalet in Denmark, where it is analysed histologically. Subsequently, the results are stored in the national pathology database. A CT of the

thorax and abdomen is conducted at the time of the diagnosis to identify any metastases and determine the TNM level (any further MRI for rectal cancer is also performed in Denmark). Additionally, CTs are described by a radiology specialist from Denmark. Furthermore, neoadjuvant radiotherapy, neoadjuvant chemotherapy and surgical interventions for metastatic disease (affecting the lungs and liver) are conducted in Denmark. Finally, adjuvant and palliative chemotherapy for oncology patients is administered at the medical department of the QIH.

Following surgical resection, patients without radiological or histological evidence of malignancy are considered cancer-free and are monitored according to the Danish surveillance protocol. Patients with malignant lymph nodes or adjacent structures are offered adjuvant chemotherapy, while patients with metastatic disease left in situ may receive palliative chemotherapy depending on their overall health status. Chemotherapy is offered in Nuuk.

This study was a comprehensive assessment of CRC among the Greenlandic population, specifically examining whether Greenlanders have higher CRC mortality rates than other countries such as Denmark. Furthermore, we aimed to explore the relationship between cancer stages, mortality rates, comorbidities and treatment modalities.

Methods

This was a registry-based, observational retrospective study. The study population included all residents of Greenland from 2015 to 2020. Every individual in Greenland is assigned a personal identification number (CPR number), and the entire country utilises a unified medical record system, called Cosmic.

When a patient is diagnosed, a diagnosis code (DC) is entered in the patient's file.

By permission of the National Greenlandic Ethics Committee, medical files were obtained from Cosmic, and patients were identified by searching for diagnosis codes in Cosmic from 2015 to 2020. The DCs used were DC20 – Cancer of the rectum (and DC209), DC Cancer of the colon (and DC280 to 289).

The inclusion criteria were 1) permanent address in Greenland at the time of diagnosis, 2) a new CRC confirmed by histology or clinical observation. According to the International Classification of Diseases for Oncology (ICD-O-3), the following subtypes were included: adenocarcinomas, undifferentiated adenocarcinomas, mucinous adenocarcinoma, adenosquamous carcinoma, medullary carcinoma and signet cell carcinoma.

Patients were excluded if the histology was dysplasia or another non-CRC cancer.

Data extracted from medical records included date of birth; date, type and place of operation (Greenland or Denmark); presence of an anastomosis; tumour perforation (yes/no); microradical resection status; surgical approach (emergency or elective); sex; smoking status; weight; height; BMI; American Society of Anesthesiologists Physical Status Classification System (ASA) score; performance status; Charlson's Comorbidity Index (CCI) [3, 4]; postoperative complications within 30 days; anastomotic leakage (yes/no); Clavien-Dindo score (CDS) [5], TNM stage; preoperative, adjuvant and palliative chemotherapy; recurrence status and date of recurrence; vital status and date of death, or, for patients alive, date of follow-up; and place of residence.

Recurrence was documented with a minimum follow-up of five years or until death for 213 patients. For 24 patients, follow-up was shorter than five years because the date of data inventory was 15 May 2024.

Data are discussed and compared with reports from the Danish Colorectal Cancer Group (DCCG), from 2021 [6].

Statistics

Statistics were conducted in SPSS 29.0. Results are given as medians, means and ranges.

Trial registration: not relevant.

Results

Demographic and clinical characteristics

A total of 274 patients were identified with suspected carcinoma of the colon or rectum from 2015 to 2020. In all, 37 (13%) were excluded; 25 patients because they were diagnosed outside the observation period, seven with a benign histology, four patients because the histological diagnosis revealed another type of cancer, one patient due to missing information because the patient had left Greenland.

A total of 237 people were included in the study.

Table 1 shows the distribution of the population according to clinical characteristics and demographics.

TABLE 1 Demographic and clinical characteristics (N = 237).

Age, median (range), yrs	64 (33-96)
Sex, n (%)	
Male	122 (52)
Female	115 (48)
ASA score, n (%)	
1	26 (11)
2	147 (62)
3	60 (25)
4	4 (2)
Performance status, n (%)	
0	180 (76)
> 0	57 (34)
CCI group, n (%)	
1	12 (5)
2	95 (40)
3	93 (39)
4	31 (13)
5	6 (3)
Smoking, n (%)	
No smoking	59 (25)
Active	127 (54)
Former smoker	48 (20)
Unknown	3 (1)
BMI group, n (%)	
< 20 kg/m^2	19 (8)
20-25 kg/m^2	68 (29)
26-30 kg/m^2	76 (32)
31-35 kg/m^2	50 (21)
> 35 kg/m^2	16 (7)
Unknown	8 (3)
Geographic location, n (%)	
Coastal towns	173 (73)
Nuuk	64 (27)

ASA = American Society of Anesthesiologists Physical Status Classification System; CCI = Charlson Comorbidity Index.

Surgical treatment

Table 2 presents the surgical characteristics for the studied population.

TABLE 2 Surgical characteristics for the 237 patients with colorectal cancer in Greenland, 2015-2020.

	Frequency, n (%)
Resection?	
No[a]	35 (15)
Yes	202 (85)
Cancer type	
Colon	168 (71)
Rectal	69 (29)
Perforated tumour?	
Yes	20 (8)
No	217 (92)
Clinical UICC stage	
I	26 (11)
II	43 (18)
III	81 (34)
IV	86 (36)
Unknown	< 5 (1)
Surgery type	
None	25 (10)
Right hemicolectomy	61 (26)
Extended right hemicolectomy	20 (8)
Transversum	< 5 (< 2)
Left hemicolectomy	12 (5)
Sigmoideum	45 (19)
Rectum:	
Resection	36 (15)
Intersphincteric	< 5 (< 2)
Extralevatory	8 (3)
Subtotal colectomy	13 (6)
Total proctocolectomy	< 5 (< 2)
Endoscopic resection	< 5 (< 2)
Explorative laparotomy	7 (3)
Location of operation	
No operation	25 (10)
Greenland	156 (66)
Denmark	56 (24)

	Frequency, n (%)
Anastomosis?	
No	82 (35)
Yes	155 (65)
Radical resection colon	
R0	100 (59)
R1	33 (20)
R2	22 (13)
No resection	13 (8)
Subtotal	168 (100)
Radical resection rectum	
R0	38 (55)
R1	11 (16)
R2	< 5 (< 2)
No resection	19 (28)
Subtotal	69 (100)
Clavien Dindo classification	
0	30 (13)
1-3[a]	166 (70)
> 3[a]	41 (17)
Anastomosis leakage among colon anastomoses?	
Yes	3 (2)
No	124 (98)
Total	127 (100)
Anastomosis leakage among rectal anastomoses?	
Yes	9 (32)
No	19 (68)
Subtotal	28 (100)

UICC = Union for International Cancer Control.
a) Endoscopic resection included.

The majority of patients had Union for International Cancer Control (UICC) stage III and IV at the time of diagnosis. The median lymph node harvest 18 for colon resections and 23 for rectal resections. The R0-rate was low for both colon (59%) and rectal resections (55%). Furthermore, the results show that anastomosis leakage for rectal anastomosis was 32%.

Table 3 shows the distribution of stomas.

TABLE 3 Anastomosis and stomas.

	Anastomosis, n				Surgery, n		
Surgery type	none	anastomosis	relieving stoma	end stoma	elective	acute	Total, n (%)
None	25	0	0	0	25	0	25 (10.5)
Hemicolectomy							
Right	0	58	0	3	52	9	61 (25.7)
Extended right	0	17	0	3	13	7	20 (8.4)
Transversum	0	1	0	0	1	0	1 (0.4)
Left hemicolectomy	1	8	0	3	8	4	12 (5.1)
Sigmoideum	0	30	1	14	36	9	45 (19.0)
Rectum							
Resection	0	13	15	8	34	2	36 (15.2)
Intersphincteric	0	0	0	3	3	0	3 (1.3)
Extralevatory	0	0	0	8	8	0	8 (3.4)
Subtotal colectomy	0	10	0	3	6	7	13 (5.5)
Total proctocolectomy	0	0	1	2	2	1	3 (1.3)
Endoscopic resection	3	0	0	0	3	0	3 (1.3)
Explorative laparotomy	1	0	0	6	5	2	7 (3.0)
Total	30	137	17	53	196	41	237 (100)

Oncological treatment

Out of the 237 patients with CRC, 105 (44.3%) received adjuvant chemotherapy after surgical treatment. 81% of patients with CRC under 80 years of age in stage III received adjuvant chemotherapy.

Mortality and survival rate

The overall 30-day mortality rate was 3.5%. Among patients undergoing elective surgery, 30- and 90-day mortality rates were identical (colon: 2.5%; rectum: 2.1%). Among patients undergoing acute surgery, the combined 90-day mortality rate for colon and rectum procedures was 10%.

The five-year survival rate for patients with colon cancer was 43%; for rectum cancer, 47%, overall. Among patients who had elective surgery, the five-year-survival was 49% for patients with colon cancer; 68% for patients with rectum cancer.

Survival after resection of both rectum and colon by stage averaged as follows: 6.1 years (95% CI: 4.8-7.4 years) for stage I, 7.0 years (95% CI: 6.0-8.1 years) for stage II, 6.4 years (95% CI: 5.6-7.3 years) for stage III and 2.4 years (95% CI: 1.9-2.8 years) for stage IV disease. For patients without resection, the mean overall survival time was 0.7 years (95% CI: 0.5-1.0 years).

Log-rank analyses showed no significant association between place of residence and mortality. Patients had the same stage of disease at the time of diagnosis, and there was no significant ($p = 0.6$) difference in survival for stage IV cancers with respect to residence (Nuuk versus coastline). Furthermore, there were no differences in mortality between men and women among patients with colon or rectal cancer ($p = 0.9$ and $p = 0.6$).

Recurrence

After radical operative treatment, 47% experienced no recurrence. During five years of follow-up, local recurrence was 3% and remote recurrence 16% for CRC.

Regardless of treatment status, 34% were never cancer-free after their initial diagnosis.

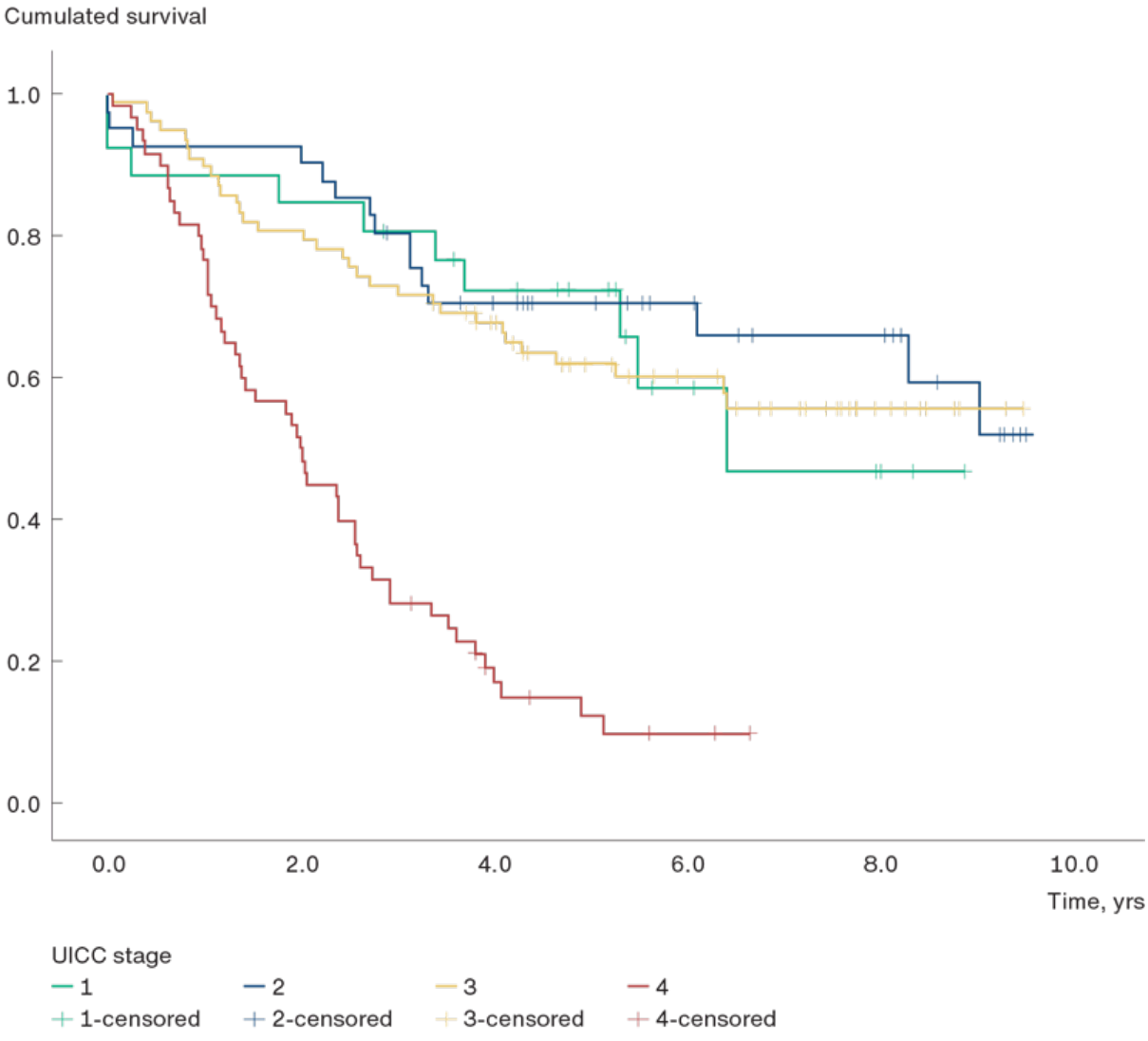
Comparison with Denmark

The Greenlandic population was younger at diagnosis than the Danish population. The proportion of patients

with clinical UICC stage I for CRC in Greenland was 11%. In Denmark, the corresponding proportion was 30% in 2020 [6]. In the studied population, 34% were classified as UICC stage III and 36% as stage IV. By comparison, corresponding figures in the DCCG cohort from 2020 were 29% for stage III and 22% for stage IV for CRC.

The overall survival rates among CRC patients in Greenland were 78% at one year, 53% at three years and 43% at five years for colon cancer; 78%, 56%, and 47%, respectively, for rectal cancer. In comparison, in Denmark in 2019, survival rates were 81%, 67% and 57%, respectively, for colon cancer; 87%, 47% and 62%, respectively, for rectum cancer. In **Figure 1**, the five-year-survival among both colon and rectum patients (combined) is shown by stage. The survival rates for patients with stage I, II and III are very similar. Patients with stage IV for both colon and rectum had a five-year survival rate of 10%. For electively operated patients, the five-year-survival was slightly higher at 17.5%. This is lower than in Denmark, where for stage IV with elective operation, the rate was 39% for colon and 40% for rectum [6].

FIGURE 1 Survival stratified by Union for International Cancer Control (UICC) stages for colorectal cancer in Greenland in 2015-2020.



Comparison with Danish data [7] shows that stoma formation in colon surgery is generally more frequent in Greenland.

Discussion

The incidence of CRC is roughly the same in the two countries (71 per 100,000 annually in Greenland versus 73 per 100,000 in Denmark [6]). However, the Greenlandic population was younger and had more advanced disease at the time of their diagnosis. The median age at diagnosis in Greenland was 64 years, compared with 71 years in Denmark [8].

A previous study from 2021 [9] on CRC in Greenland found that women had a lower survival rate than men. This was not confirmed in the present study, where survival among men and women showed no difference, which may reflect a more complete registration in the present study of all patients with proven CRC in the observation period.

Despite logistical challenges in Greenland, the results showed no difference in survival between patients living in Nuuk and those residing in coastal towns. The stage of disease at diagnosis was similar, regardless of the place of residence.

CTs performed in Greenland may not have been described by radiologists accustomed to describing CRCs. This may potentially affect preoperative staging, but not for rectal cancers, as these scans were evaluated by experts in Denmark.

Post-operative mortality (for all ages) after elective surgery was the same at 30 days and 90 days: colon, 2.5%; rectum, 2.1%. According to the DCCG, in 2020, post-operative 30-day mortality among electively operated patients < 75 years of age was 0.8%, and the corresponding 90-day mortality was 1.5%. This indicates that selection for surgery may be similar in Greenland and Denmark. Lymph node harvest in Greenland also indicates that the quality of surgery may not be inferior. The relatively low R0 rates in Greenland may be due to the presence of very advanced cancers in the population.

Furthermore, the higher occurrence of stomas in the colon in Greenland than in Denmark may partly be due to the higher rate of urgent procedures. According to Statistics Greenland [1], the average lifespan in 2020 was 71.5 years for men and 76 years for women. In Denmark, it was 79.6 years for men and 83.6 years for women in 2020 [10].

Lifestyle-related diseases are more frequent in Greenland than in Denmark. Thus, 52% of the Greenlandic population are active smokers [11] compared with 19% in Denmark [10]. Furthermore, diabetes and heart diseases are increasing in Greenland [12, 13], and suicide and death from unnatural causes are notably higher in Greenland than in Denmark [1, 10].

Comparing the Inuit population in Greenland with other Inuit populations worldwide, the American Indian/Alaska Native population in Alaska had the highest documented CRC incidence rate in the world in 2018 (61.9/100,000) [14]. The cause of this high CRC incidence rate is not fully described, but a high presence of smokers, low levels of physical activity and a change of diet have been considered plausible reasons. Similar conditions may apply to the Greenlandic population.

A surprising finding in the studied population was the high rate of anastomosis leakage in rectal cancer. These patients were operated in Denmark, and the findings therefore cannot be explained by surgical standards in Greenland. However, the finding may potentially be explained by patient deterioration due to advanced tumour stage, and the fact that 55% of the patients who experienced anastomosis leakage in the Greenlandic rectal cancer group were active smokers.

On 1 March 2014, a national CRC screening programme was launched in Denmark.

CRC screening is currently not available in Greenland, and it is considered logistically unattainable. However,

faecal immunochemical testing (FIT) is being introduced for symptomatic patients regardless of age. A positive test will lead to referral for a colonoscopy within two weeks, although we foresee logistical difficulties in meeting this requirement. This initiative may potentially address doctors' delays and late-stage cancer diagnoses. Along with the new testing, it might be considered to launch an information campaign in Greenland.

Due to limited treatment options in Greenland, some patients are referred to Denmark for surgery or neoadjuvant chemotherapy, often requiring extended stays away from home and family. This can lead to some treatment decline because patients are not interested in leaving home. Despite these challenges, 82% of UICC stage III CRC patients received adjuvant chemotherapy, which is comparable to the 80% for colon and 88% recorded for rectal cancer in Denmark in 2020 [4, 6].

Conclusions

The incidence of colorectal cancer in Greenland is comparable to that in Denmark; however, the Greenland population was younger and nevertheless exhibited poorer survival. This may reflect an overall reduced survival and, in particular, a higher proportion of advanced disease at diagnosis, as there were no indications from other parameters of inferior surgical quality in Greenland. Surgical outcomes, however, are also affected by disease stage at diagnosis.

The logistical challenges of diagnostic measures and treatment for patients living outside the capital, Nuuk, do not appear to affect survival rates.

The authors hope that this study provides useful information on CRC in Greenland and helps maintain the high standard of treatment provided to the Greenlandic population.

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