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## ORIGINAL ARTICLE

# Long-term quality of life, sexual health and gastrointestinal function following colorectal cancer resection in an Asian cohort

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## Abstract

**Aim:** As populations age and cancer management improves, long-term survivorship and quality-of-life (QOL) outcomes are becoming equally important as oncological results. Data from Asian populations are scarce. We aimed to evaluate the sexual health, gastrointestinal function and QOL amongst colorectal cancer survivors in a tertiary referral centre in Singapore.

**Method:** Adults who had undergone elective curative surgery for non-metastatic colorectal cancer at least 2 years prior were included. Exclusion criteria were cognitive disease, serious postoperative complications or recurrent cancer. Participants were invited to complete the European Organization for Research and Treatment of Cancer Quality of Life Questionnaires EORTC-QLQ-C30 and QLQ-CR29. Using multiple bivariate analysis, *r* scores were used to examine relationship trends between QOL domains and survivor sociodemographic and disease-specific characteristics.

**Results:** From February 2017 to July 2019, 400 responses were recorded. Median age and follow-up duration were 64 years (range 32–90) and 78 months (interquartile range 49–113) respectively. Patients who had Stage III cancer had better overall QOL scores compared to Stage I/II. Rectal (vs. colon) cancer negatively influenced sexual health and gastrointestinal function, but did not appear to affect overall QOL. Amongst our cohort, 57% (*n* = 129) of men and 43% (*n* = 75) of women were sexually active. Markers of socioeconomic status, including employment, education and housing type, were found to significantly impact perception of various aspects of QOL.

**Conclusion:** Knowledge of factors which influence well-being can identify individuals who may benefit from tailored management strategies. Regular patient–doctor contact may play a role in building and maintaining positive perspectives of cancer survivors. Normative data should be obtained from local populations to facilitate future comparative research.

## KEYWORDS

colorectal cancer survivorship, gastrointestinal function, quality of life, sexual function, Singapore

## INTRODUCTION

Colorectal cancer is the most common cancer in Singapore [1] and consistently ranks amongst the top three malignancies in developed countries [2]. Economic progress and improved healthcare give rise to an ageing population, along with an increased incidence of cancers associated with older persons [3]. According to a 2017 Ministry of Health report, in collaboration with the United States based Institute of Health Metrics and Evaluation, Singaporeans are the world's longest-lived people with a life expectancy of 84.8 years but are also expected to spend 10.6 years in ill health, 1.5 years longer than in 1990 [4]. Furthermore, cancer was found to be the second highest contributor of disability and poor health [4].

Colorectal cancer survival rates have progressively improved, with 65% of all colorectal cancer patients living beyond 5 years from diagnosis [5]. In Singapore, mortality rates for colorectal cancer have steadily decreased from 2001 onwards [1]. This results in a significant number of people who have undergone curative surgery, often with chemotherapy and radiotherapy, living well into their later years. Accordingly, there has been increasing emphasis on longer-term quality of life (QOL) and functional outcomes amongst colorectal cancer survivors, particularly in Western countries. These data can help inform healthcare providers, carers and governments as to the resources and infrastructure that may be required to assist these people to live productive and healthy lives over the long term.

There is considerable discrepancy between the clinician perspective and patient experience in quantifying QOL [6,7]. Therefore, patient reported outcome measures are key to understanding the needs of survivors of colorectal cancer. Patient reported outcome measure questionnaires have been developed and validated to assess various aspects of function, ranging from the physical, psychological and sexual, to unmet needs, whether social or financial. These questionnaires have come into use in recent years and are instrumental in helping to guide longer-term treatment strategies.

Culture and belief systems can influence perceptions of outcomes across different geographical locations [8]. Relatively few survivorship analyses have been conducted in an Asian population. Only recently, the ACTION study group analysed health-related QOL and psychological distress amongst cancer survivors from eight low- and middle-income Southeast Asian countries [9]. Concerning colorectal-cancer-specific survivorship, only one Thai study out of 11 was included in a 2018 meta-analysis on post-resection functional outcomes [10,11] and one Japanese study out of 10 in a 2010 colorectal cancer survivor QOL review [12,13]. Moreover, sexual function is an often neglected [14] and somewhat taboo topic in Asian societies. Only a handful of studies have looked at sexual function following colorectal surgery in an Asian cohort [15,16]. Issues with postoperative sexual function were not raised by patients themselves in a recent qualitative analysis on a small sample of cancer survivors in our own cohort [17].

In this study, we aimed to evaluate the sexual health, gastrointestinal function and overall QOL amongst colorectal cancer survivors in a tertiary referral centre in Singapore, a highly developed country with the highest urban population density in Southeast Asia. In

### What does this paper add to the literature?

This study is one of the largest to date examining colorectal cancer survivorship in Asia. These data can help inform healthcare providers, carers and governments as to the resources and infrastructure that may be required to assist these people to live productive and healthy lives over the long term.

addition, we explored the relationship between survivor physical, emotional and sexual health with individual socioeconomic characteristics and disease-specific factors.

## METHODS

### Setting and patient recruitment

Through electronic hospital records, research coordinators identified postoperative colorectal cancer patients scheduled for follow-up from February 2017 to July 2019 with their colorectal specialist at Singapore General Hospital, the largest public hospital in Singapore.

Inclusion criteria were patients who had undergone curative surgery for non-metastatic colorectal cancer at least 2 years prior to consultation. Patients were excluded if they were younger than 21 years old, had distant metastases, had concurrent or prior diagnosis of a non-colorectal malignancy, or had a history of cognitive impairment rendering them unable to complete the questionnaire. Patients who underwent emergency surgery, experienced serious early postoperative complications or developed cancer recurrence were also excluded from recruitment.

A study invitation letter including a participant information leaflet was mailed to patients who met the inclusion criteria prior to their appointment, informing them of the possibility of study participation after specialist consultation.

### Study measures

Following outpatient clinician consultation, eligible patients were approached by research coordinators for study participation. Consenting individuals were invited to complete the European Organization for Research and Treatment of Cancer Quality of Life Questionnaires EORTC QLQ-C30 and QLQ-CR29, as well as a general survey of their sociodemographic and oncological history. The questionnaires were available in two different languages, English and Chinese, which are the most spoken languages in Singapore. On-site translators were available for patients who spoke other languages. For illiterate patients, the research coordinators read the survey questions and recorded patient replies. The questionnaire forms were collected immediately upon completion. Recruitment

was stopped after the target number of 400 patient responses was reached.

The EORTC QLQ-C30 questionnaire was developed to assess QOL in cancer patients [18] while QLQ-CR29 is a supplementary questionnaire designed specifically for evaluation of colorectal cancer patients [19]. Both questionnaires have been used in combination [20–23] and have been verified and validated for ethnically Chinese populations [16,24,25].

The EORTC QLQ-C30 and QLQ-CR29 questionnaires consist of 30 and 29 questions respectively. The questions can be interpreted singly or grouped to represent a particular dimension of the patient's QOL or function. For example, the questions associated with the 'Role functioning' dimension pertain to perceived limitations in work, daily or recreational activities. These questions pertain to the patient's experience over the recent 1 week prior, or a period of 4 weeks for those relating to sexual health. The accumulated scores from the different questions were then linearly converted to a 0–100 scale as directed by the EORTC scoring manual for ease of interpretation [18,19].

For the QOL analysis, we selected eight dimensions from the EORTC QLQ-C30: Physical functioning, Role functioning, Emotional functioning, Cognitive functioning, Social functioning, Fatigue symptoms, Financial symptoms and Global quality of life. For the domains of sexual health and gastrointestinal/urinary function, we selected eight dimensions to represent each as well, all chosen from the EORTC QLQ-CR29. For sexual health, these were Body image, Anxiety, Weight, Sexual interest (men), Sexual interest (female), Embarrassment, Impotence and Dyspareunia. To represent gastrointestinal/urinary function the selected dimensions were Urinary frequency, Stool frequency, Urinary incontinence, Abdominal pain, Buttock pain, Bloating, Flatulence and Faecal incontinence.

Statistical analysis was performed using SPSS version 25.0 (SPSS Inc.). Bivariate analyses were performed using Student's *t* test. Ethics approval for the study was granted by the SingHealth centralized institutional review board (reference number 2016/2747).

## RESULTS

The CONSORT flow diagram is shown in Figure 1. A total of 1247 colorectal cancer patients were scheduled for outpatient follow-up with their colorectal specialist within the study duration. After screening for eligibility using electronic health records, 914 patients met the study inclusion criteria and were contacted by mail regarding potential recruitment. Our research coordinators physically approached 485 patients, with 83 declining participation in the study and two withdrawing before questionnaire completion, citing time limitations. 429 eligible patients were not approached for enrolment; of these, manpower resource constraints precluded contact with 369 patients and the study recruit target had already been achieved before the remaining 60 patients were scheduled for a clinic appointment.

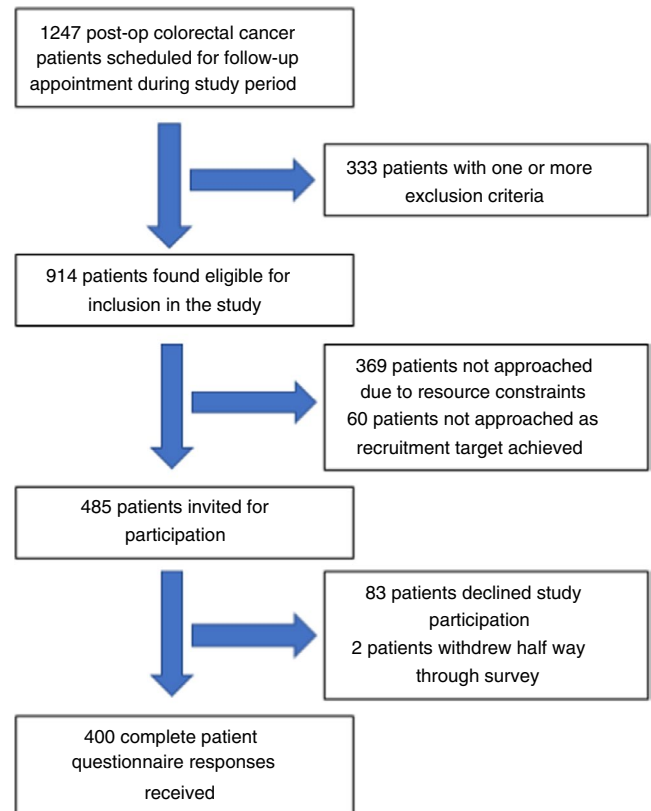


FIGURE 1 CONSORT diagram

Patient sociodemographic, surgical and oncological characteristics are shown in Table 1. Bivariate analyses between the selected dimensions to represent QOL and patient sociodemographic, surgical and disease factors are shown in Table 2. The relationships between the individual dimensions of sexual health and gastrointestinal/urinary function and the patient sociodemographic, surgical and oncological factors are shown in Tables 3 and 4, respectively. Only responses from sexually active patients were analysed for the dimensions of sexual interest and dyspareunia. Table 5 shows the relationship between age and sexual activity for each gender in our cohort.

## DISCUSSION

The interaction between the different factors influencing the various aspects of a patient's overall well-being following major oncological surgery is complex. To simplify the analysis, we break down the discussion by the respective domains of overall QOL, sexual health, and gastrointestinal or urinary function.

### Quality of life

Tumour stage significantly influenced most dimensions of overall QOL (Table 2). Notably, patients with Stage III cancer reported

**TABLE 1** Patient sociodemographic, surgical and disease characteristics

	Frequency (%) (n = 400)
Age, median (years)	64
Age, range (years)	32–90
Gender	
Male	227 (56.8)
Female	173 (43.3)
Race	
Chinese	360 (90.0)
Malay	15 (3.8)
Indian	17 (4.3)
Others	8 (2.0)
Marital status	
Single	61 (15.3)
Married	286 (71.5)
Divorced/separated	23 (5.8)
Widowed	30 (7.5)
Education	
No formal education	12 (3.0)
Primary school	77 (19.3)
Secondary school	113 (28.3)
GCE O/A levels/Diploma	152 (38.0)
Degree and above	46 (11.5)
Employment	
Employed	184 (46.0)
Unemployed	56 (14.0)
Retired	160 (40)
Housing	
Government housing	332 (83.0)
Private housing	68 (17.0)
Religion	
Has a religion	326 (81.5)
No religion	74 (18.5)
Year of surgery	
2000–2009	144 (36.0)
2010–2015	256 (64.0)
Tumour site	
Colon	213 (53.3)
Rectum	167 (41.8)
Synchronous colon and rectum	20 (5.0)
Surgical approach	
Open	244 (61.0)
Minimally invasive	156 (39.0)
Stoma	
No stoma	287 (71.8)
Temporary stoma	97 (24.3)

(Continues)

**TABLE 1** (Continued)

	Frequency (%) (n = 400)
Permanent stoma	16 (4.0)
AJCC TMN stage <sup>a</sup>	
I	88 (22.0)
II	146 (36.5)
III	166 (41.5)
Adjuvant chemotherapy	
No	206 (51.5)
Yes	194 (48.5)
Follow-up, median (months)	78
Follow-up, interquartile range (months)	49–113

<sup>a</sup>American Joint Committee on Cancer, 7th Edition.

better physical, cognitive and global health scores, as well as less fatigue, compared to patients with Stage I and II cancer. There was a similar trend with patients who had received adjuvant chemotherapy; these patients experienced better physical, emotional, social functioning and less fatigue compared to those who did not undergo chemotherapy.

There are several possible explanations for this occurrence. Patients who had been diagnosed with more advanced malignancy would have experienced more intensive follow-up, including blood tests, endoscopy and surveillance scans, in addition to chemotherapy. This would have been a physically and emotionally stressful phase and subsequent recovery may have resulted in a more optimistic outlook relative to patients with a less eventful postoperative period. This phenomenon can be observed in a study reporting higher psychological QOL scores amongst cancer survivors compared to age-specific normative scores from the general population [26]. The increased frequency of clinician consultation for patients with higher-staged disease or those requiring chemotherapy may have provided opportunity for reassurance or management of expectations by their health-care providers, potentially leading to better perceived outcomes. The positive relationship between clinical consultation and outcomes has been described previously, albeit in a palliative care setting [27].

Interestingly, tumour site (colon vs. rectum) and the presence of temporary ostomy did not show any significant difference in any of the eight dimensions of QOL examined. This contrasts with their influence on sexual health and gastrointestinal/urinary function, as discussed later.

Men performed favourably on the physical and emotional functioning aspects of QOL compared to women, but worse on the role, cognitive, social functioning aspects, although the difference between the latter three did not reach statistical significance. There was also no difference in global health scores between the genders. Increasing age only resulted in poorer physical functioning, with no effect on other components of QOL.

In our study cohort, which had a median age of 64 years, 46% (n = 184) were employed at the time of the survey. Employment was associated with consistently worse results in all aspects of QOL,

TABLE 2 Relationships between EORTC QLQ-C30 (Quality of Life) dimensions and patient/disease factors

	Physical <sup>a</sup>	Role <sup>a</sup>	Emotional <sup>a</sup>	Cognitive <sup>a</sup>	Social <sup>a</sup>	Fatigue <sup>b</sup>	Financial <sup>b</sup>	Global health scale <sup>a</sup>
Gender								
Male (n = 227) versus	90.5 ± 13.6	91.9 ± 18.7	93.5 ± 12.7	86.4 ± 17.0	95.8 ± 12.4	16.0 ± 18.3	13.1 ± 23.9	75.9 ± 19.1
Female (n = 173)	87.4 ± 15.7	92.9 ± 16.7	90.1 ± 14.6	87.1 ± 15.9	96.1 ± 11.7	18.3 ± 19.6	10.6 ± 23.5	78.3 ± 16.7
P value	0.033	0.572	0.012	0.687	0.781	0.219	0.303	0.190
Age in years								
<60 (n = 110) versus	92.6 ± 11.1	92.6 ± 11.1	90.4 ± 15.3	87.5 ± 7.9	95.6 ± 12.2	18.9 ± 19.7	11.8 ± 23.2	77.1 ± 17.0
≥60 (n = 290)	87.8 ± 15.2	91.9 ± 17.9	92.6 ± 12.9	86.3 ± 15.9	96.0 ± 11.6	16.2 ± 18.5	12.0 ± 23.9	76.8 ± 18.4
P value	0.003	0.540	0.152	0.519	0.713	0.189	0.925	0.849
<70 (n = 297) versus	91.0 ± 11.8	93.2 ± 16.0	91.8 ± 13.9	87.3 ± 16.6	95.8 ± 12.1	16.5 ± 18.8	12.4 ± 23.6	77.7 ± 17.7
≥70 (n = 103)	83.4 ± 18.9	89.4 ± 22.1	92.4 ± 12.8	84.9 ± 16.2	96.2 ± 10.6	18.1 ± 19.0	10.6 ± 23.8	74.5 ± 18.8
P value	0.000	0.064	0.708	0.211	0.750	0.474	0.513	0.118
Tumour site								
Colon (n = 213) versus	89.2 ± 15.1	93.5 ± 16.2	92.8 ± 13.1	86.7 ± 16.1	96.6 ± 11.4	17.9 ± 19.9	10.6 ± 22.4	77.0 ± 17.8
Rectum (n = 167)	89.4 ± 13.0	91.0 ± 18.4	92.0 ± 11.9	87.0 ± 16.0	95.4 ± 11.8	15.8 ± 16.4	13.1 ± 23.4	77.2 ± 17.5
P value	0.899	0.151	0.548	0.881	0.308	0.259	0.285	0.925
Tumour stage								
Stage I-II (n = 234) versus	87.8 ± 15.9	93.1 ± 17.0	91.3 ± 14.6	85.1 ± 17.7	95.0 ± 13.4	18.7 ± 20.6	11.6 ± 24.4	75.2 ± 19.2
Stage III (n = 166)	90.8 ± 11.7	91.0 ± 18.9	92.9 ± 12.1	88.9 ± 14.3	97.2 ± 8.8	14.4 ± 15.7	12.4 ± 22.7	79.2 ± 15.9
P value	0.033	0.247	0.251	0.022	0.057	0.025	0.750	0.028
Surgical approach								
Open (n = 244) versus	87.8 ± 16.0	91.8 ± 18.8	92.3 ± 13.7	87.3 ± 16.1	96.4 ± 11.3	16.7 ± 19.2	11.7 ± 23.6	76.3 ± 18.0
MIS (n = 156)	91.4 ± 11.0	93.3 ± 15.8	92.0 ± 12.8	86.0 ± 16.4	95.4 ± 12.4	16.9 ± 18.1	12.1 ± 23.8	78.2 ± 17.7
P value	0.019	0.414	0.808	0.445	0.411	0.911	0.849	0.314
Stoma								
No stoma (n = 287) versus	89.4 ± 14.6	92.8 ± 18.1	92.2 ± 13.7	86.8 ± 16.5	96.5 ± 11.3	17.0 ± 19.6	11.4 ± 23.8	77.1 ± 18.0
Temporary stoma (n = 97)	88.9 ± 13.1	91.0 ± 16.6	91.6 ± 13.0	86.0 ± 16.4	93.9 ± 13.4	15.8 ± 16.8	12.3 ± 21.1	76.2 ± 17.9
P value	0.768	0.391	0.703	0.683	0.065	0.570	0.749	0.646
Chemotherapy								
No (n = 206) versus	87.2 ± 16.2	91.9 ± 19.4	90.5 ± 15.1	85.2 ± 17.7	94.4 ± 14.1	19.9 ± 21.5	12.2 ± 24.4	75.9 ± 18.2
Yes (n = 194)	91.1 ± 11.8	92.6 ± 15.9	93.6 ± 11.6	88.2 ± 14.9	97.5 ± 8.3	13.8 ± 14.9	11.6 ± 23.0	77.9 ± 17.8
P value	0.007	0.659	0.026	0.074	0.010	0.001	0.796	0.261

(Continues)

TABLE 2 (Continued)

	Physical <sup>a</sup>	Role <sup>a</sup>	Emotional <sup>a</sup>	Cognitive <sup>a</sup>	Social <sup>a</sup>	Fatigue <sup>b</sup>	Financial <sup>b</sup>	Global health scale <sup>a</sup>
Follow-up duration								
2–5 years (n = 139) versus	87.6 ± 15.6	90.2 ± 21.1	90.6 ± 16.5	83.6 ± 19.1	94.7 ± 14.4	19.2 ± 18.9	16.3 ± 28.7	76.4 ± 18.8
>5 years (n = 261)	89.9 ± 13.6	93.3 ± 15.7	92.7 ± 11.7	88.3 ± 14.7	96.6 ± 10.0	15.7 ± 18.7	9.7 ± 20.2	77.1 ± 17.6
P value	0.131	0.101	0.136	0.008	0.127	0.077	0.008	0.700
Education								
<O level (n = 202) versus	87.7 ± 15.5	93.2 ± 17.7	92.8 ± 13.1	87.7 ± 16.6	97.1 ± 9.4	15.7 ± 18.8	13.6 ± 27.1	77.7 ± 19.4
≥O level (n = 198)	90.4 ± 13.0	91.3 ± 17.9	91.2 ± 14.0	85.6 ± 16.3	94.7 ± 13.6	18.2 ± 18.8	10.2 ± 19.6	76.0 ± 16.5
P value	0.063	0.286	0.248	0.223	0.048	0.185	0.149	0.368
Employment								
Employed (n = 184) versus	86.2 ± 16.5	90.8 ± 19.6	91.8 ± 13.6	84.9 ± 16.6	95.1 ± 13.3	17.0 ± 18.8	13.8 ± 26.3	77.0 ± 17.7
Unemployed/ retired (n = 216)	92.4 ± 10.4	94.0 ± 15.4	92.2 ± 13.7	88.7 ± 16.1	96.9 ± 9.5	16.9 ± 18.9	9.7 ± 20.0	76.7 ± 18.4
P value	0.000	0.073	0.820	0.021	0.132	0.950	0.085	0.842
Housing								
Government (n = 332) versus	88.6 ± 14.6	92.1 ± 17.7	91.8 ± 14.2	87.1 ± 16.3	95.9 ± 12.1	16.9 ± 19.3	12.9 ± 24.9	76.7 ± 18.7
Private (n = 68)	91.2 ± 12.9	92.8 ± 18.2	93.1 ± 10.2	84.5 ± 17.5	96.0 ± 10.0	16.9 ± 16.7	7.3 ± 16.1	77.9 ± 14.3
P value	0.176	0.761	0.468	0.240	0.927	0.992	0.076	0.609
Religion								
Has religion (n = 326) versus	88.7 ± 15.0	92.4 ± 17.4	91.8 ± 14.2	86.8 ± 16.6	95.8 ± 12.1	16.8 ± 19.0	12.3 ± 24.3	77.5 ± 18.3
No religion (n = 74)	90.8 ± 10.8	91.6 ± 19.5	93.0 ± 10.5	86.0 ± 16.3	96.6 ± 10.3	17.7 ± 18.2	10.3 ± 20.5	74.2 ± 16.8
P value	0.263	0.739	0.496	0.699	0.592	0.707	0.511	0.154

Notes: Values in parentheses represent frequency. All scores are denoted as mean ± SD. P values of <0.05 were taken as statistically significant and indicated by red font.

Abbreviation: MIS, minimally invasive surgery.

<sup>a</sup>For these dimensions, a higher score corresponds to a more favourable response for the patient.

<sup>b</sup>For these dimensions, a lower score corresponds to a more favourable response for the patient.

with statistical significance in the physical and cognitive aspects. While the minimum retirement age in Singapore is 62 years at present, with plans to raise the age to 63 years in 2022, over one-quarter of Singaporeans aged 65 and over are still actively employed [28]. Employment is typically correlated with a higher socioeconomic status, although the converse may be true for elderly workers close to retirement age. Further dedicated research in this area is warranted, including evaluation of the workplace environment and work satisfaction for senior citizens and cancer survivors.

## Sexual health and body image

The impact on sexual function is an important consideration for colorectal cancer patients, given that most colorectal cancer survivors will remain sexually active after treatment [29] (Table 3). An older age had the anticipated effect of decreasing libido for both sexes in our cohort, although elderly patients had less body image and embarrassment issues. Our postoperative patients aged 70 and above had less sex than the general population of similar age in the

TABLE 3 Relationships between EORTC QLQ-CR29 (Sexual Health) dimensions and patient/disease factors

	Body image <sup>a</sup>	Anxiety <sup>a</sup>	Weight <sup>a</sup>	Sexual interest <sup>a</sup> (men)	Sexual interest <sup>a</sup> (women)	Embarrassment <sup>b</sup>	Impotence <sup>b</sup> (men)	Dyspareunia <sup>b</sup> (women)
Gender								
Male (n = 227) versus	93.7 ± 15.6	80.7 ± 24.0	86.9 ± 21.5	30.4 ± 27.1	NA	4.8 ± 14.7	28.9 ± 35.3	NA
Female (n = 173)	94.0 ± 15.3	75.7 ± 26.9	82.0 ± 24.5	NA	15.8 ± 21.3	4.6 ± 16.6	NA	4.1 ± 11.1
P value	0.820	0.049	0.036			0.888		
Age in years								
<60 (n = 110) versus	91.3 ± 20.4	75.4 ± 28.0	81.2 ± 26.1	38.8 ± 32.8	29.8 ± 21.9	7.2 ± 19.8	27.5 ± 34.7	8.7 ± 15.0
≥60 (n = 290)	94.8 ± 13.0	79.7 ± 24.2	86.2 ± 21.5	27.9 ± 25.0	3.17 ± 10.0	3.7 ± 13.4	29.3 ± 35.6	0 ± 0
P value	0.040	0.130	0.052	0.000	0.000	0.046	0.752	0.011
<70 years (n = 297) versus	93.4 ± 15.9	77.4 ± 25.7	83.2 ± 23.7	31.9 ± 26.3	22.2 ± 22.6	5.1 ± 16.7	25.8 ± 33.5	6.1 ± 13.1
≥70 (n = 103)	95.1 ± 13.9	81.8 ± 24.1	89.3 ± 19.9	27.9 ± 28.6	2.5 ± 9.2	3.5 ± 11.3	37.0 ± 38.8	0 ± 0
P value	0.340	0.127	0.021	0.023	0.005	0.368	0.032	0.102
Tumour site								
Colon (n = 213) versus	96.2 ± 9.2	78.7 ± 23.6	85.4 ± 21.7	33.3 ± 25.1	25.0 ± 25.1	1.8 ± 8.9	24.6 ± 30.4	2.7 ± 9.6
Rectum (n = 167)	91.3 ± 19.2	78.4 ± 26.1	83.2 ± 24.7	25.2 ± 26.3	10.2 ± 18.3	7.3 ± 18.4	33.3 ± 39.3	5.1 ± 12.2
P value	0.001	0.915	0.355	0.179	0.058	0.000	0.071	0.563
Tumour stage								
Stage I-II (n = 234) versus	92.8 ± 18.0	77.3 ± 27.0	83.6 ± 24.1	30.2 ± 24.4	11.1 ± 19.2	5.6 ± 17.8	31.9 ± 35.9	4.7 ± 11.9
Stage III (n = 166)	95.3 ± 10.8	80.3 ± 22.9	86.5 ± 21.0	30.7 ± 32.5	21.0 ± 22.8	3.4 ± 11.3	23.9 ± 33.9	3.5 ± 10.5
P value	0.105	0.250	0.209	0.936	0.143	0.148	0.099	0.728
Surgical approach								
Open (n = 244) versus	94.6 ± 13.5	79.6 ± 24.9	85.6 ± 22.2	30.3 ± 23.3	11.1 ± 27.2	4.2 ± 14.7	25.8 ± 33.8	5.5 ± 13.6
MIS (n = 156)	93.9 ± 16.4	77.7 ± 24.8	83.9 ± 22.9	33.3 ± 23.5	22.2 ± 19.2	5.2 ± 16.5	32.0 ± 36.2	11.1 ± 19.2
P value	0.659	0.466	0.455	0.777	0.553	0.530	0.211	0.626
Stoma								
No stoma (n = 287) versus	95.5 ± 13.0	78.9 ± 24.2	85.2 ± 22.3	32.1 ± 28.4	9.1 ± 20.3	3.4 ± 13.2	26.3 ± 33.1	4.7 ± 11.8
Temporary stoma (n = 97)	90.9 ± 17.6	78.0 ± 29.2	84.8 ± 23.5	26.0 ± 24.5	17.0 ± 22.5	6.5 ± 16.4	31.8 ± 36.7	2.7 ± 9.6
P value	0.006	0.747	0.890	0.374	0.236	0.066	0.286	0.613
Chemotherapy								
No (n = 206) versus	93.0 ± 16.8	75.7 ± 28.3	83.3 ± 24.5	30.0 ± 27.0	12.7 ± 20.6	4.8 ± 16.0	31.6 ± 34.9	3.8 ± 13.8
Yes (n = 194)	94.7 ± 13.8	81.6 ± 21.4	86.4 ± 21.0	26.0 ± 27.6	13.2 ± 20.8	4.6 ± 15.0	25.9 ± 35.6	3.1 ± 13.1
P value	0.260	0.020	0.178	0.280	0.871	0.890	0.224	0.723
Follow-up duration								

(Continues)

TABLE 3 (Continued)

	Body image <sup>a</sup>	Anxiety <sup>a</sup>	Weight <sup>a</sup>	Sexual interest <sup>a</sup> (men)	Sexual interest <sup>a</sup> (women)	Embarrassment <sup>b</sup>	Impotence <sup>b</sup> (men)	Dyspareunia <sup>b</sup> (women)
2–5 years (n = 139) versus	92.9 ± 16.5	76.2 ± 28.4	85.3 ± 21.6	26.0 ± 28.3	15.6 ± 23.9	3.1 ± 13.8	29.9 ± 35.2	4.4 ± 15.6
>5 years (n = 261)	94.3 ± 14.8	79.8 ± 23.6	84.5 ± 23.6	32.1 ± 26.7	15.9 ± 19.7	5.6 ± 16.3	28.3 ± 35.5	3.9 ± 12.2
P value	0.385	0.182	0.733	0.368	0.971	0.126	0.749	0.489
Education								
<O level (n = 202) versus	94.9 ± 15.8	81.8 ± 24.6	87.7 ± 20.8	21.9 ± 27.4	5.8 ± 13.0	3.3 ± 14.4	22.4 ± 33.7	1.9 ± 11.6
≥O level (n = 198)	92.8 ± 15.0	92.8 ± 15.0	81.8 ± 24.5	39.3 ± 24.0	23.1 ± 23.4	6.2 ± 16.4	35.3 ± 35.8	5.1 ± 15.0
P value	0.171	0.009	0.009	0.004	0.009	0.060	0.005	0.209
Employment								
Employed (n = 184) versus	93.5 ± 16.4	79.6 ± 25.2	85.0 ± 23.9	35.8 ± 29.0	22.9 ± 23.4	5.5 ± 18.1	31.8 ± 36.8	8.3 ± 14.9
Unemployed/ retired (n = 216)	94.3 ± 14.2	77.3 ± 25.6	84.6 ± 21.7	25.2 ± 24.4	11.1 ± 18.8	3.8 ± 11.7	26.0 ± 33.7	3.3 ± 6.8
P value	0.605	0.373	0.852	0.078	0.086	0.262	0.214	0.053
Housing								
Government (n = 332) versus	93.7 ± 16.4	77.7 ± 26.7	84.8 ± 23.0	29.7 ± 27.7	18.2 ± 22.5	4.9 ± 16.3	29.3 ± 36.0	4.3 ± 11.3
Private (n = 68)	94.6 ± 9.8	82.8 ± 16.7	84.8 ± 22.6	33.3 ± 25.1	7.40 ± 14.7	3.9 ± 10.8	26.2 ± 30.9	3.7 ± 11.1
P value	0.675	0.129	0.991	0.627	0.182	0.630	0.640	0.890
Religion								
Has religion (n = 326) versus	93.8 ± 15.4	78.7 ± 25.5	85.2 ± 22.9	25.9 ± 26.4	10.4 ± 19.8	4.7 ± 15.6	27.9 ± 34.8	3.8 ± 14.3
No religion (n = 74)	93.9 ± 15.8	77.9 ± 24.8	82.8 ± 22.9	39.3 ± 26.6	14.1 ± 25.2	4.9 ± 15.2	32.6 ± 37.3	3.2 ± 6.5
P value	0.949	0.806	0.419	0.032	0.406	.0.900	0.414	0.371

Notes: Values in parentheses represent frequency. All scores are denoted as mean ± SD. P values of <0.05 were taken as statistically significant and indicated by red font.

Only the responses of sexually active patients were reported for the dimension of sexual interest (men and women) and dyspareunia (women).

Abbreviation: MIS, minimally invasive surgery.

<sup>a</sup>For these dimensions, a higher score corresponds to a more favourable response for the patient.

<sup>b</sup>For these dimensions, a lower score corresponds to a more favourable response for the patient.

large English Longitudinal Study of Ageing (ELSA) study, with 44% versus 54% of men and 29% versus 31% of women respectively reporting continuing sexual activity [29]. To date, there is no normative data for sexual activity in the general elderly population in Singapore. Male colorectal cancer survivors had less anxiety and weight concerns compared to their female counterparts.

The presence of a stoma has consistently been associated with diminished body image and reduced sexual interest [30–32] which may result from the underlying disease or the psychosocial

impact of the ostomy. In our study, a previous temporary ostomy adversely affected patient body image and worsened embarrassment scores long after the stoma had been reversed, compared to having no ostomy at all. Despite the lingering effect on body image, a previous ostomy did not appear to significantly influence sexual interest or function (impotence and dyspareunia) in our patients.

Rectal cancer surgery is often implicated with postoperative sexual dysfunction [33,34] secondary to injury to the pelvic autonomic

TABLE 4 Relationships between EORTC QLQ-CR29 (Gastrointestinal/urinary) dimensions and patient/disease factors

	Urinary frequency <sup>a</sup>	Stool frequency <sup>a</sup>	Urinary incontinence <sup>a</sup>	Abdominal pain <sup>a</sup>	Buttock pain <sup>a</sup>	Bloating <sup>a</sup>	Flatulence <sup>a</sup>	Faecal incontinence <sup>a</sup>
Gender								
Male (n = 227)	21.4 ± 23.8	10.5 ± 18.0	7.4 ± 15.9	3.8 ± 12.3	4.4 ± 13.3	9.1 ± 18.6	15.4 ± 22.2	6.1 ± 15.3
versus								
Female (n = 173)	16.9 ± 21.8	6.5 ± 13.9	7.1 ± 14.6	5.2 ± 14.1	4.2 ± 13.7	10.4 ± 20.1	17.1 ± 24.2	3.6 ± 12.6
P value	0.054	0.016	0.838	0.297	0.903	0.506	0.459	0.083
Age in years								
<60 (n = 110)	19.8 ± 24.8	10.9 ± 18.9	6.9 ± 15.7	8.1 ± 17.0	4.5 ± 15.9	13.6 ± 23.1	16.3 ± 22.4	5.4 ± 13.1
versus								
≥60 (n = 290)	19.3 ± 22.4	8.0 ± 15.4	7.4 ± 15.2	2.9 ± 11.0	4.2 ± 12.4	8.1 ± 17.4	16.0 ± 23.3	4.9 ± 14.7
P value	0.853	0.122	0.760	0.000	0.847	0.011	0.917	0.750
<70 years (n = 297)	19.4 ± 22.8	19.4 ± 22.8	6.8 ± 15.3	5.3 ± 14.5	4.8 ± 14.5	10.6 ± 20.3	16.2 ± 23.1	5.2 ± 14.4
versus								
≥70 (n = 103)	19.7 ± 23.8	7.9 ± 15.9	7.9 ± 15.9	1.6 ± 7.1	2.9 ± 9.4	6.7 ± 15.7	15.8 ± 23.2	4.5 ± 14.0
P value	0.902	0.519	0.263	0.012	0.215	0.080	0.875	0.650
Tumour site								
Colon (n = 213)	18.9 ± 23.3	5.8 ± 13.6	6.2 ± 14.9	3.7 ± 11.5	2.3 ± 9.1	8.4 ± 18.3	12.3 ± 20.4	2.8 ± 9.2
versus								
Rectum (n = 167)	19.5 ± 21.4	11.1 ± 18.1	8.9 ± 15.7	4.7 ± 13.8	6.9 ± 17.4	11.3 ± 20.9	20.9 ± 25.2	6.9 ± 17.8
P value	0.789	0.001	0.090	0.427	0.001	0.148	0.000	0.004
Tumour stage								
Stage I-II (n = 234)	20.7 ± 23.8	9.4 ± 17.5	7.7 ± 16.0	4.9 ± 14.1	4.5 ± 14.0	11.5 ± 21.7	17.6 ± 24.3	4.9 ± 14.1
versus								
Stage III (n = 166)	17.6 ± 21.9	7.9 ± 14.8	6.8 ± 14.4	6.8 ± 14.4	4.0 ± 12.6	7.0 ± 15.0	14.0 ± 21.1	5.2 ± 14.6
P value	0.183	0.358	0.566	0.304	0.692	0.021	0.124	0.872
Surgical approach								
Open (n = 244)	18.2 ± 23.2	8.6 ± 16.0	6.2 ± 14.3	4.6 ± 13.7	3.3 ± 12.0	9.5 ± 19.6	15.0 ± 22.7	4.5 ± 12.2
versus								
MIS (n = 156)	21.1 ± 22.7	8.6 ± 16.6	9.1 ± 16.8	3.6 ± 11.8	5.9 ± 15.5	8.9 ± 17.6	17.2 ± 23.9	5.9 ± 17.4
P value	0.232	0.994	0.066	0.465	0.060	0.786	0.361	0.344
Stoma								
No stoma (n = 287)	19.04 ± 23.5	6.8 ± 14.6	6.8 ± 15.3	4.5 ± 13.3	3.2 ± 11.7	9.5 ± 19.3	13.4 ± 21.6	3.3 ± 12.4
versus								
Temporary stoma (n = 97)	20.1 ± 21.5	14.9 ± 20.7	7.9 ± 15.0	4.1 ± 12.9	7.2 ± 16.8	10.9 ± 20.2	21.9 ± 25.8	8.2 ± 15.9
P value	0.697	0.000	0.530	0.794	0.011	0.523	0.002	0.002
Chemotherapy								
No (n = 206)	22.1 ± 25.0	9.6 ± 17.5	8.2 ± 16.5	5.5 ± 14.7	4.3 ± 13.8	11.9 ± 21.5	17.1 ± 23.6	3.7 ± 11.9
versus								
Yes (n = 194)	16.6 ± 20.5	7.9 ± 15.3	6.3 ± 14.0	3.2 ± 11.0	4.2 ± 13.0	7.2 ± 16.4	15.1 ± 22.5	6.5 ± 16.3
P value	0.017	0.322	0.227	0.089	0.957	0.014	0.380	0.050
Follow-up duration								
2-5 years (n = 139)	21.1 ± 24.6	8.5 ± 17.5	7.2 ± 16.9	3.8 ± 12.7	5.7 ± 16.5	11.2 ± 20.6	17.7 ± 23.8	5.2 ± 14.0
versus								

(Continues)

TABLE 4 (Continued)

	Urinary frequency <sup>a</sup>	Stool frequency <sup>a</sup>	Urinary incontinence <sup>a</sup>	Abdominal pain <sup>a</sup>	Buttock pain <sup>a</sup>	Bloating <sup>a</sup>	Flatulence <sup>a</sup>	Faecal incontinence <sup>a</sup>
>5 years (n = 261)	18.6 ± 22.2	9.0 ± 15.9	7.4 ± 14.4	4.7 ± 13.3	3.5 ± 11.5	8.8 ± 18.5	15.3 ± 22.7	4.9 ± 14.4
P value	0.312	0.778	0.921	0.520	0.124	0.227	0.319	0.845
Education								
<O level (n = 202) versus	15.8 ± 19.5	6.5 ± 14.6	4.6 ± 11.5	2.6 ± 10.1	2.9 ± 11.6	7.7 ± 17.6	14.1 ± 22.7	4.1 ± 13.2
≥O level (n = 198)	23.2 ± 25.7	11.1 ± 17.9	10.1 ± 18.0	6.2 ± 15.4	5.7 ± 15.0	11.6 ± 20.8	18.1 ± 23.4	6.0 ± 15.2
P value	0.001	0.004	0.000	0.006	0.041	0.046	0.084	0.177
Employment								
Employed (n = 184) versus	20.1 ± 22.7	8.3 ± 15.9	9.4 ± 17.3	4.0 ± 13.0	4.3 ± 13.7	8.6 ± 18.1	16.5 ± 23.8	5.0 ± 15.0
Unemployed/retired (n = 216)	18.7 ± 23.5	9.4 ± 17.1	4.8 ± 12.3	4.8 ± 13.2	4.3 ± 13.2	10.8 ± 20.6	15.7 ± 22.2	5.0 ± 13.4
P value	0.550	0.512	0.003	0.506	0.984	0.251	0.746	0.989
Housing								
Government (n = 332) versus	18.2 ± 22.4	8.4 ± 16.4	7.0 ± 15.0	3.6 ± 12.1	4.0 ± 13.3	8.9 ± 18.4	15.2 ± 22.6	4.9 ± 13.9
Private (n = 68)	25.4 ± 25.5	10.5 ± 16.7	8.8 ± 16.9	8.3 ± 16.6	5.8 ± 14.0	13.2 ± 23.1	20.5 ± 25.1	5.8 ± 16.2
P value	0.019	0.350	0.387	0.007	0.299	0.095	0.083	0.614
Religion								
Has religion (n = 326) versus	18.8 ± 23.2	8.3 ± 15.6	7.3 ± 15.7	4.2 ± 12.8	3.9 ± 12.8	9.5 ± 19.0	16.1 ± 23.0	4.9 ± 13.1
No religion (74)	22.5 ± 22.3	11.0 ± 19.7	7.2 ± 13.8	4.9 ± 14.2	5.8 ± 15.9	10.3 ± 20.5	16.2 ± 23.5	5.8 ± 18.5
P value	0.213	0.204	0.929	0.697	0.282	0.733	0.984	0.608

Notes: Values in parentheses represent frequency. All scores are denoted as mean ± SD. P values of <0.05 were taken as statistically significant and indicated by red font.

Abbreviation: MIS, minimally invasive surgery.

<sup>a</sup>For these dimensions, a lower score corresponds to a more favourable response for the patient.

TABLE 5 Age and sexual activity in colorectal cancer survivors

Gender (n = 400)	Age	Sexually active (% per gender)	Not sexually active (% per gender)
Male (227)	<70 years old	102 (44.9)	64 (28.2)
	≥70 years old	27 (11.9)	34 (15.0)
Female (173)	<70 years old	63 (36.4)	68 (39.3)
	≥70 years old	12 (6.9)	30 (17.3)

plexuses and irradiation to the pelvis. Sympathetic damage in men can cause problems with ejaculation and in women the loss of contractions during orgasm. Parasympathetic injury results in erectile dysfunction in men and vaginal dryness or dyspareunia in women. The incidence of sexual disorders after total mesorectal excision for rectal cancer is estimated to be 10%–35% [35]. Colon cancer

survivors have also been found to report a higher rate of sexual dysfunction compared to a normative population [36] which may be less a result of autonomic nerve impairment and more multifactorial in nature. In one study, patients experienced an adverse impact on their sexual lives because of postoperative gastrointestinal problems [34]. In our cohort, rectal cancer patients experienced poorer

sexual interest and function compared to colon cancer patients for either gender, although these differences did not reach statistical significance.

An open surgical approach was not shown to negatively impact any domain of sexual health including body image, anxiety, weight, embarrassment, impotence, dyspareunia, compared to patients who underwent minimally invasive surgery.

Employment appeared to enhance sexual interest scores for both men and women, although this may be confounded by other factors including younger age and better general health. Education seemed to play an important role in sexual health as well, with better educated patients regardless of gender exhibiting significantly higher sexual interest scores. This is despite better educated men and women reporting more issues with erectile dysfunction and dyspareunia, respectively.

### Gastrointestinal and urinary function

Analysis of the gastrointestinal and urinary dimensions of the colorectal-cancer-specific EORTC QLQ-CR29 yielded several notable observations (Table 4). Compared to those who had colon cancer, patients who had surgery for rectal cancer recorded consistently worse scores across all symptom dimensions. Patients who had a previous ostomy similarly reported worse symptom scores compared to those who never had a stoma, reflecting the association between defunctioning ostomy and rectal cancer surgery. These findings demonstrate the increased risk of urinary and bowel dysfunction in rectal cancer surgery [21]. Additional risk factors for these symptoms are a shorter tumour distance from the anal verge and the use of radiotherapy [11]. There appeared to be no difference in long-term function between patients who had undergone laparoscopic colorectal surgery compared to a traditional open approach.

No significant trend towards symptomatic improvement could be found for colorectal cancer survivors with a longer follow-up duration of >5 years versus 2–5 years. Adaptation of bowel function has previously been shown to be unlikely beyond 18 months postrectal surgery [37]. Similarly, body image issues, sexual interest and function did not improve significantly following a more extended follow-up period (Table 3). This may imply that peak recovery of libido and sexual function also occurs within and not after a 5-year postoperative period. However, for components of QOL, patients at least 5 years from surgery registered a better score across all dimensions, achieving statistical significance in cognitive functioning and financial status, suggesting continued improvement in these areas beyond 5 years (Table 2).

As was the case with sexual function, education level appeared to negatively influence perception of postoperative gastrointestinal symptoms, with better educated patients reporting worse symptom scores. Consistently poorer symptom trends were also documented for patients residing in private housing compared to those staying in lower-cost public accommodation. Education level and housing type are known individual-level measures of socioeconomic status. More

than 80% of Singapore's resident population live in public housing, of whom 90% own their home [38]. Our findings may reflect more affluent patients having higher health literacy or greater means to seek treatment and diagnose abnormal function. Public rental housing in Singapore, a marker of lower socioeconomic status compared to self-ownership of residence, has been associated with poorer health status and outcomes, with increased hospital utilization [39].

### Limitations and strengths

This study is limited by selection and survivorship bias. Functional results and QOL outcomes may have been confounded by the presence of comorbidities more prevalent in the elderly population, including diabetes, ischaemic heart disease, musculoskeletal issues, depression or cognitive deterioration. The level of social support amongst cancer survivors is also an important risk factor for recovery of health-related QOL [40]. Regarding sexual interest and function, the significance of the findings should be interpreted with caution, in view of the relatively small number of sexually active patients in our cohort, particularly women above 70. In our study, multiple bivariate analyses were used to demonstrate trends between relevant sociodemographic/surgical characteristics and selected aspects of function and QOL. This serves to identify current knowledge deficiencies as well as possible areas of interest, paving the way for prospective multivariate research to better understand the relationships between key variables.

Aside from the EORTC questionnaires, another scoring system frequently used to assess bowel function following anterior resection is the low anterior resection syndrome (LARS) questionnaire, which evaluates the symptoms of incontinence, stool frequency, clustering and bowel urgency, collectively termed LARS [41]. In our study, the use of the LARS questionnaire was decided against for several reasons. The LARS questionnaire is validated for use in patients after anterior resection of the rectum, but not in colonic resection. Moreover, EORTC QLQ-CR29 already covers a similar range of questions to the LARS questionnaire concerning bowel dysfunction and may have led to confusion amongst the mostly elderly survey respondents.

To ensure participant comprehension and completion of the questionnaire, direct supervision of the patient was provided by a dedicated research coordinator during the survey process. This was particularly important in a multilingual, multi-ethnic country such as Singapore. This study is also one of the largest to date evaluating colorectal cancer survivorship in an Asian setting.

### CONCLUSION

As populations age and management of cancer continues to improve, long-term survivorship outcomes are becoming as important to patients as oncological results. Knowledge of the factors which influence well-being can potentially improve the therapeutic

relationship and decision-making process between clinicians and patients, as well as help identify individuals who may benefit from special attention and tailored management strategies. Regular purposeful patient-doctor contact may play a role in building and maintaining positive perspectives of cancer survivors, explaining why patients with Stage III cancer and those who received chemotherapy had better overall QOL scores compared to patients with early-stage malignancy. As a considerable proportion of patients remain sexually active, even in their later years, healthcare providers should initiate early discussion regarding sexual dysfunction and provide adequate referral resources for sexual health following colorectal cancer surgery. Markers of socioeconomic status, including employment, education and housing type, were found to significantly impact perception of various aspects of post-cancer recovery of function and QOL, which in turn have clinical and economic implications. It is necessary to evaluate QOL norms via larger scale population-based research, so as to facilitate future comparative research.

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## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

## PATIENT CONSENT STATEMENT

All patients provided written consent for participation in this study.

## AUTHOR CONTRIBUTION

ISE and EKWT contributed to the design and implementation of the study, interpreting the results and initial drafting of the manuscript. AYC, DBM, SWY and DQC contributed to critical analysis and writing of the final manuscript.

## DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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