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## Quality-of-Life and Surgical Treatments for Rectal Cancer-a Longitudinal Analysis Using the California Cancer Registry

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### Abstract

**Background**—Heterogeneous results for research investigating health-related quality of life (HRQL) in patients undergoing sphincter-ablating procedures for rectal cancer are likely due to single institution experiences and measurement of HRQL. To address this heterogeneity, we evaluated HRQL in patients with rectal cancer by type of surgery, location of tumor and receipt of adjuvant therapy using an HRQL instrument that has not been used to address rectal cancer patients in a population-based sample over time.

**Methods**—The Functional Assessment of Cancer Therapy-Colorectal instrument (FACT-C) instrument was administered at 9 and 19 months after diagnosis to a consecutive sample of 160 patients in Northern California identified by the California Cancer Registry. A broad multidimensional interpretation of HRQL was used to examine the impact of tumor location and treatment status, stage of disease, age and gender.

**Results**—In general, men had lower social well-being scores and younger patients had lower physical and emotional well-being scores and colorectal concerns scores. We found no differences in HRQL by either tumor location or type of surgery, at either 9 or 19 months after diagnosis. Lower physical well-being and greater adverse colorectal concerns were reported at 9 months

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among patients who received adjuvant therapy; however, only adverse colorectal concerns persisted over time.

**Conclusions**—This study provides additional evidence that sphincter-ablating procedures do not necessarily reduce quality of life in patients with rectal cancer. Distinctive features of this study include a broad multidimensional interpretation of HRQL, the 19 months of longitudinal follow-up, and a prospective population-based study design.

### Keywords

rectal cancer oncology quality-of-life

## Introduction

Postoperative health-related quality of life (HRQL) is an important outcome for the approximately 35,000 patients who undergo surgery for rectal cancer each year in the US [1-3]. Abdominoperineal resection (APR) is historically the preferred surgical procedure when the tumor is close to the anus [3,4], although it results in a permanent colostomy with its obvious shortcomings. Sphincter-sparing techniques such as low anterior resection (LAR) can avoid a colostomy but may contribute to pain, nerve damage, sexual dysfunction, bowel and urinary problems [5,6]. Research on the impact of location of anastomosis on fecal continence has generated conflicting results [7,8] and the impact on overall HRQL is uncertain.

Most studies evaluating post-operative HRQL in patients with rectal cancer hypothesize that sphincter ablating surgery is associated with worse HRQL than sphincter-sparing surgery. Although older studies confirm this hypothesis, more recent research findings are conflicting [9-12]. These differences have resulted in the search for tools to assess function and well-being after surgery for rectal cancer as an active area of investigation [13-14]. The Functional Assessment of Cancer Therapy-Colorectal (FACT-C) was developed to measure HRQL in patients with cancer of the colon or rectum [15]. We are not aware of research using the FACT-C to address the association of HRQL, treatment and tumor characteristics in rectal cancer patients exclusively. Older studies had methodological shortcomings [15], but in more recent studies evaluating HRQL with comprehensive, validated instruments, conflicting associations may be due to patients selected at specific institutions receiving differing quality of follow-up care and differences in the interpretation of HRQL.

Health-related quality of life is the patient's multidimensional and subjective appraisal and satisfaction with their current level of functioning as compared to what they perceive to be ideal [17,18]. A recent review by Pachler et al. and a meta-analysis by Cornish et al. challenge the assumption that APR impairs patients' HRQL and conclude that more research is needed [19,20]. Since recommended adjuvant therapy [21-28] can decrease HRQL due to side effects [29,30] but also improve HRQL due to better expected health outcomes [31], adjuvant therapy must also be considered. The objective of this study is to investigate rectal cancer patients' postoperative HRQL based on a broad multidimensional interpretation of HRQL using the FACT-C in a prospective population-based cohort. Specifically, we will assess whether HRQL differs by tumor location, type of surgery (APR. vs. LAR) and receipt of adjuvant therapy.

## Materials and Methods

Eligible patients included incident cases of rectal cancer in persons aged 40-84 years of age who were diagnosed between April 1, 1999 and June 30, 2000 in nine Northern California counties and reported to the California Cancer Registry (CCR). Incident cases were

collected via rapid case ascertainment within 3 months of diagnosis. Only participants with adenocarcinoma who underwent segmental resection (i.e. anterior resection, low anterior resection) or total proctectomy (i.e. APR) procedures were included. Subjects who did not speak English or Spanish were excluded.

After informed consent was obtained, trained interviewers administered a telephone survey to patients as previously described [32,33]. The first set of interviews was conducted an average of 9 months after diagnosis and a follow-up survey was administered an average of 19 months after diagnosis. Surveys were mailed to patients who did not respond after 15 phone contacts or who specified such a preference. Patients were offered a \$20 stipend for completing the survey. Institutional review boards of the Public Health Institute, California Department of Health Services, Northern California Cancer Center, and Harvard Medical School approved the study protocol.

The registry collects demographic, clinical, and treatment information from medical facilities. Treatment variables included type of surgical procedure, reason for no surgery, receipt of radiation therapy, sequence of radiation relative to surgery, and receipt of chemotherapy. Information on the anatomic location of tumor was obtained from a text abstract that summarizes information from patient admission, surgery, radiology, endoscopy and pathology reports found in the medical chart. Although this information is not required, it is present in about 80% of registry records. The presence of this data is not dependent on the patient, it is dependent on the completeness of the medical records and abstraction. Other researchers have utilized location of tumor data from the registry [34]. The location was categorized as the lower rectum (0-5 cm from anal verge), the middle rectum (6-10 cm from the anal verge) and the upper rectum (11-15 cm from the anal verge)[34]. Stage of disease was categorized before treatment using the staging criteria of the American Joint Committee on Cancer converted from SEER Extent of Disease [35].

Patients were surveyed with the FACT-C, a general HRQL instrument combined with a colorectal subscale targeting colorectal cancer patients receiving treatment [15]. The subscales have been validated independent of the total score [15,36]. The five FACT-C subscales include physical well-being, functional well-being, emotional well-being, social/family well-being and colorectal cancer specific concerns. The physical well-being subscale includes questions that reveal how a patient feels (energy levels, pain, side effects and ability to meet their needs). The social/family well-being subscale deals with issues involving family and friends and includes an item on satisfaction with sexual issues. The emotional well-being subscale deals with fear, sadness, nervousness, hope and coping abilities. The functional well-being subscale involves enjoyment with life, recreation and work and sleeping patterns. The colorectal concerns subscale includes questions about bowel function, digestion, appetite, and body appearance.

Patients rated each item on a scale from 0 (not at all) to 4 (very much) according to how much that item pertained to them in the past 7 days. Questions were scored so that a higher score always corresponds to better HRQL. The questions in each subscale were summed to create a final score for each domain, if more than 50 percent of the items comprising the subscale were answered. Missing data were imputed from the average of all the completed items in that subscale if more than half of the items within the subscale were answered [37]. Possible scores for the physical, social/family, functional, and colorectal concerns subscales range from 0 to 28 and possible scores for the emotional subscale range from 0 to 24. Higher subscale scores indicate better well-being.

The FACT-C showed good internal consistency reliability as assessed using inter-item and corrected item subscale correlations and Cronbach's alpha [15]. The FACT-C also showed

good concurrent validity as assessed by comparison with the Functional Living Index-Cancer, Brief Profile of Mood States, and Marlowe-Crowne Social Desirability Scale, Profile of Mood States, the Eastern Cooperative Oncology Group Performance Status Rating, and Neuroticism Scale in the Eysenck Personality Questionnaire [15,38]. Also the FACT-C was able to distinguish between groups based on functional status, change in functional status and extent of disease [15]. The Spanish version of the FACT-C is reliable and valid for use in research with colorectal cancer patients [15]. Additionally, the FACT-C showed some advantages over the QLQ-CR38 in a French study of patients with colorectal cancer [39].

The overall HRQL of these patients was modeled with multivariate analysis of variance (MANOVA), addressing all 5 correlated subscales simultaneously with Wilks' Lambda multivariate significance test of mean differences. MANOVA allowed us to account for correlations among a linear combination of all five HRQL subscales and to investigate the effects of our variables (surgery type, location of tumor, receipt of adjuvant treatment, stage of disease, age group and gender). This method helps identify stronger relationships than are observable from any single HRQL variable alone [37]. Specifically, it reduces the number of post-hoc analyses and reduces the probability of a Type I error; MANOVA controls the experiment-wide error rate. It acts as a gateway through the Wilks Lambda test statistic. If the Wilks's Lambda test statistic showed significant differences, post-hoc ANOVA comparisons were conducted to assess the HRQL subscales individually using Bonferroni's adjustment for multiple comparisons and a type I error rate of 0.05. We also conducted repeated measures analysis of variance over time using data from both the initial response and follow-up survey to assess the significance of change over time in HRQL scores. Chi Square analysis was used to assess the potential bias in our main hypotheses due to non-response (completers vs non-completers). Kolmogorov-Smirnov was used to assess normality of scores. All analyses were conducted in SAS [40].

Stage IV patients were excluded from analyses of the association between HRQL and adjuvant treatment because they are receiving palliative care and are not being treated for cure. Stage I patients were included, although this treatment approach does not meet NIH guidelines, because these patients presumably had tumors that were aggressive in a way other than stage (i.e. poorly differentiated) and they were being treated for cure. Stage II and III were grouped together since NIH recommends similar treatments. HRQL varies by stage of disease [41], therefore, we stratified our analysis by stage.

A sample size calculation was conducted at the proposal stage of this project [42]. Given that average values for subscales are in the range of 19-25 and standard deviations are 6.0 or smaller [15], a power calculation using an alpha error level of 0.05 and a beta error level of 0.2, our subgroup analyses have sufficient power to detect statistically significant differences.

## Results

A total of 216 rectal cancer patients were eligible for the initial survey. 160 patients responded to the initial survey so the response rate was 74 percent. Due to resource constraints, only 123 of the 160 patients who responded to the first survey were invited to participate in the follow-up survey. Out of 123 patients, 89 completed the follow-up survey resulting in a 72 percent response rate. In the follow-up survey, 15 of the original responders to the first survey could not be contacted and 17 refused to participate in the follow-up survey.

To assess potential bias when testing our main hypothesis, we compare the characteristics of completers and non-completers of the first and follow-up (second) surveys in Table 1. Of the completers, total-completers responded to all surveys (the first and follow-up surveys). First-survey completers are those that completed only the first survey. The non-completers include total non-completers (those that did not respond to any survey) and second-survey non-completers (those that responded to the first survey and were invited to the follow-up survey but did not respond to the second survey). Although first-survey completers were slightly younger than total non-completers ( $p=0.003$ ) and total-completers were more likely to be female (48 vs. 39 percent) and to have been diagnosed at Stage I (38 vs. 27 percent) compared to first-survey completers, there were no other statistically significant differences between completers and non-completers to the initial survey.

LAR was performed in 95 percent of patients with tumors in the upper rectum, 72 percent of those with tumors in the middle rectum and 36 percent of those with tumors in the lower rectum ( $p<0.001$ ). Receipt of any type of adjuvant treatment ( $p=0.50$ ) and stage of disease did not vary by location of tumor ( $p=0.50$ ). Twenty percent of stage I, 82 percent of stage II patients and 80 percent of stage III patients received both chemotherapy and radiation therapy. All but two participants had begun adjuvant therapy by the initial survey date; 88 percent had completed radiation treatment and 55 percent had completed chemotherapy.

The mean age at diagnosis did not vary by type of surgery ( $p=0.48$ ), but those receiving adjuvant therapy were significantly younger ( $p<0.02$ ). Participants with tumors high in the rectum were younger than those with tumors low in the rectum ( $p=0.01$ ). There was no significant difference in the gender of participants by type of surgery or receipt of adjuvant therapy.

### Initial Survey Response

The scores were in the normal range, so scores were not transformed. Table 2 shows the means and standard deviations of FACT-C scores by gender, race/ethnicity, stage, location, surgery type, receipt of chemotherapy and radiation treatment for participants completing the first survey.

Except for social/family well-being, scores were highest for patients with Stage I cancer and declined slightly with increasing stage. The P-value for the Wilks Lambda test by predictor variables are shown in Table 2. Neither location of tumor nor surgery type alone nor both variables together were significantly associated with any of the five domains of HRQL in the MANOVA analysis. Gender, age and adjuvant therapy were statically significant in the MANOVA ( $p<0.009$ ). Post-hoc analysis showed males had significantly lower social well-being scores ( $p=0.004$ ) than females. The other domains did not show gender differences. Patients aged 65 years or younger had significantly lower scores on physical well-being ( $p=0.0004$ ), emotional well-being ( $p=0.006$ ), and colorectal concerns ( $p=0.02$ ) than older patients.

For adjuvant therapy, we grouped radiation and chemotherapy together, excluding the ten patients who received either therapy alone. Post-hoc analysis showed patients who received adjuvant therapy had lower physical ( $p<0.001$ ) and emotional well-being scores ( $p=0.02$ ) than patients who did not receive adjuvant treatment (Table 2).

Participants who had completed chemotherapy had significantly better scores in all subscales except social/family well-being than those who had not completed chemotherapy. Table 3 presents the post-hoc results by receipt and completion of chemotherapy.

## Follow-up Survey

There were no significant effects of surgery type or location of tumor on any subscale. While participants receiving adjuvant therapy had statistically significant lower follow-up physical well being scores than those not receiving adjuvant therapy ( $p=0.003$ ), their scores improved significantly from the initial to follow-up surveys ( $p=0.006$ ; Figure 1). However, the colorectal concerns score was significantly higher at the initial survey for patients not receiving adjuvant therapy (2.4 points,  $p=0.009$ ), and this difference persisted despite increased scores in both groups ( $p=0.04$ ; Figure 2). There were no statistically significant associations between receipt of adjuvant therapy and the other scales.

## Discussion

This study demonstrated that patients undergoing APR for rectal cancer did not have worse HRQL than patients undergoing LAR and HRQL was not affected by the anatomic location of the rectal tumor. Younger patients in general had lower HRQL than older patients. This finding is similar as other research in examining colorectal cancer patients [43,44], rectal cancer patients [45,46], breast cancer patients [47]. Since younger patients may be more active, they may perceive cancer and surgery to be a larger burden than older patients. Of those receiving adjuvant therapy, only older patients with stage I disease had lower HRQL. Patients with stage I cancer may perceive adjuvant therapy to be a larger burden than those with higher stages of disease because they are not as ill. Older patients may perceive adjuvant therapy to be a larger burden than younger patients if health status at diagnosis is worse.

Consistent with our findings, several prior studies have found that patients have better or at least similar HRQL after organ-ablating surgery than after organ-sparing surgery [48-52]. Our results are also similar to those reported from four Scottish hospitals that assessed 106 rectal cancer patients using the EORTC QLQ-C30 and QLQ-CR38 [53]. HRQL is often independent of physical symptoms; indeed, patients with major physical limitations often have high HRQL [54]. Additionally, an individual's expectation of symptoms and limitations affects the degree of distress experienced [55]. For example, patients who expect to have a well-functioning sphincter, but do not, may have poorer HRQL than patients who have a well-functioning stoma [6]. A well-designed, single institution study found that colorectal cancer patients with stomas had lower HRQL than those without stomas, but having realistic goals and expectations appeared to have an important effect on HRQL [56]. Stoma patients may have better or similar HRQL because they receive detailed information on self-care for treatment-related problems, which sphincter-sparing patients do not receive [57]. For example, Engle et al. found that patients who underwent APR had lower HRQL than patients who underwent LAR or high anterior resection but APR patients were poorly informed about stoma irrigation [9]. In the larger cohort of both colon and rectal cancer patients from which our study sample was drawn, the presence of a stoma and crude tumor location (colon vs. rectum) did not predict HRQL [33].

To our knowledge, this is the first study to examine the impact of location of tumor, type of surgery and adjuvant treatment for rectal cancer on HRQL using the FACT-C in a population-based cohort. The FACT-C is important because it is designed to detect clinically meaningful changes in scores in addition to clinically meaningful differences between groups of patients [58]. Other research examining postoperative HRQL found that sphincter-ablating surgery was associated with worse HRQL than sphincter-sparing surgery [6,56,59-69]. However, these studies were drawn from convenience samples at single institutions and most did not use validated, comprehensive HRQL instruments. Only one other study [9] examined outcomes longer than 19 months after diagnosis. Patients selected in convenience series are vulnerable to the potential bias that physicians may only have

invited 'well-adjusted' patients to participate [70]. In addition, the results may not apply to other centers with different surgeons, and may not generalize to broader populations.

The majority of recent studies have measured HRQL with the European Organization for Research and Treatment of Cancer (EORTC) Core (C)-30 and Colorectal (CR)-38. The results of these studies are conflicting [9-12,56,69,71]. Some researchers have questioned the sensitivity of EORTC-30 and CR-38 to detect differences in bowel function [13]. To overcome limitations of interpreting HRQL based on a total score as was the focus in previous studies, we examined multiple domains simultaneously using MANOVA to account for correlations among the subscales, and we adjusted for multiple comparisons to reduce our type 1 error rate. Consequently, through our analysis using MANOVA, we defined quality of life in a broad, multidimensional manner, instead of focusing individual symptoms or total scores.

Other researchers have used instruments of questionable sensitivity in rectal cancer patients, such as the Short Form-36 Medical Outcomes Survey (SF-36) and the Gastrointestinal Quality of Life Index [14]. General HRQL instruments, such as the SF-36, RAND's adaptation of the SF-36, and the Nottingham Health Profile, are designed to compare patients across many disease categories and may lead to equivocal results when a single disease is studied [69,72].

Patients with higher stage of disease had lower HRQL in physical and functional scales [42]. When we stratified our results by patient characteristics, there were no differences in HRQL by gender. Older patients with Stage I cancers receiving adjuvant treatment had worse physical well-being, emotional well-being, and colorectal concerns scores than 23 similar patients who were not receiving adjuvant therapy. These differences exceeded the threshold for a clinically important difference for FACT-C subscales, which has been estimated as 2-3 points [73,74]. Since adjuvant treatment is not generally recommended for Stage I patients [28], it is possible that those who received adjuvant treatment had some indication such as tumor behavior, which placed them at higher risk.

Receipt of chemotherapy was associated with lower HRQL, but we found that HRQL scores improved by approximately 19 months after diagnosis in patients completing both surveys, confirming others' finding that the adverse effects of adjuvant therapy on quality of life are relatively short-lived [9,72-75]. Although tumor location was predictive of type of surgery in the present study, it was not associated with HRQL. Tumor location is a very important variable that is rarely available in population-based studies. It has been postulated to confound the relationship between type of surgery and quality of life in previous research [76], but our study did not confirm this hypothesis.

In conclusion, we used a validated, multi-dimensional, cancer-specific instrument to assess postoperative HRQL in a population-based sample of patients with rectal cancer, and found neither statistically significant nor clinically meaningful differences based on tumor location or sphincter-sparing surgery. Future large studies should also assess the relation of HRQL to follow-up treatment, comorbid conditions, perceived quality of care, and evolving surgical techniques such as total mesorectal excision [77-80]. Further research is also needed to address sexual functioning, because this domain is addressed with only one item in the FACT-C. These studies can help patients and physicians to choose between different treatment regimens, especially when the more aggressive approach does not have a clear survival advantage [81]. Although this study does not report on data before patients were diagnosed with cancer, this research controls for stage of disease at diagnosis in the MANOVA, which should account for some of the unknown differences in HRQL due to disease rather than treatment. Studies of HRQL will help physicians and their patients to

make more informed decisions regarding choice of treatment, based on realistic patient expectations of symptoms and limitations.

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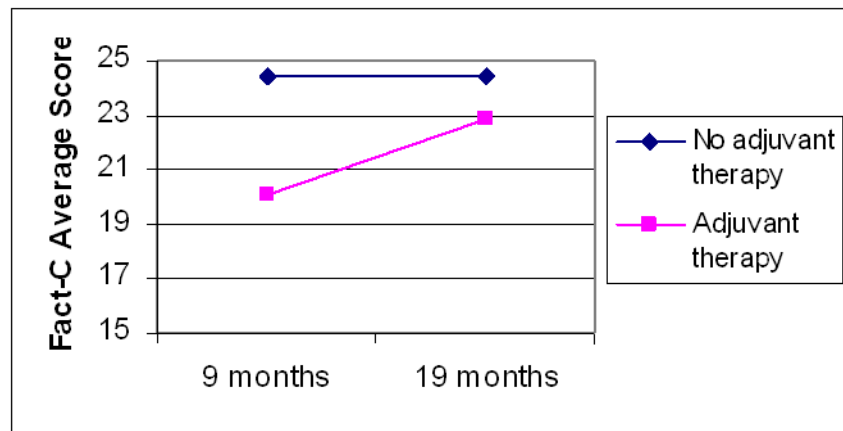


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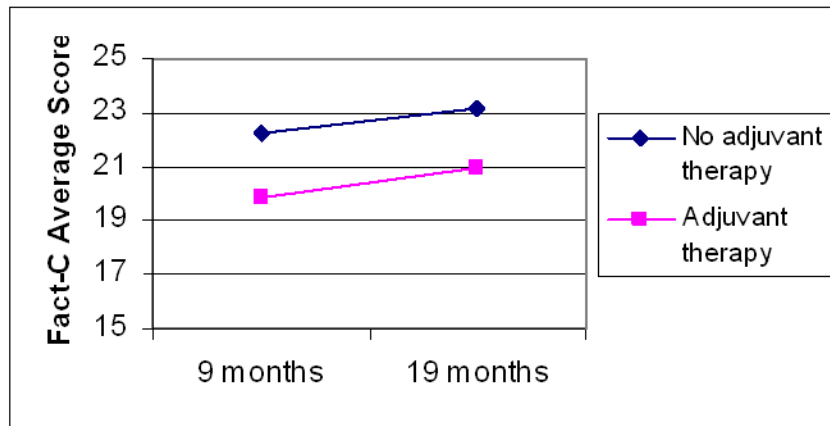
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**Figure 1.**  
FACT-C physical well being scores over time by receipt of adjuvant therapy



**Figure 2.** FACT-C colorectal concerns subscale scores over time by receipt of adjuvant therapy

**Table 1**

Characteristics of rectal cancer patients who completed and did not complete the HRQL questionnaire

Characteristic	Completers		Non-completers	
	TOTAL COMPLETERS <sup>1</sup> N=89 (%)	FIRST-SURVEY COMPLETER <sup>2</sup> N=71 (%)	TOTAL NON-COMPLETER <sup>3</sup> N=56 (%)	SECOND SURVEY NON-COMPLETER <sup>4</sup> N=34 (%)
Age (yr) mean	65.0 (10.2)	63.6 (11.8)	68.0 (10.4)	62.7 (12.9)
Gender				
Male	46 (52%)	43 (61%)	36 (64%)	20 (59%)
Female	43 (48%)	28 (39%)	20 (36%)	14 (41%)
Race				
Non-Hispanic White	72 (81%)	53 (75%)	36 (64%)	26 (76%)
Hispanic	2 (2%)	6 (5%)	4 (7%)	3 (9%)
Non-Hispanic Black	7 (8%)	4 (5%)	7 (13%)	1 (3%)
Asian/Pacific Islander	8 (9%)	8 (11%)	9 (16%)	4 (12%)
AJCC stage				
I	34 (38%)	19 (27%)	18 (32%)	10 (29%)
II	22 (25%)	19 (27%)	17 (30%)	9 (27%)
III	28 (31%)	28 (39%)	15 (27%)	13 (38%)
IV	5 (6%)	5 (7%)	6 (11%)	2 (6%)
Location in rectum				
Upper	22 (25%)	15 (21%)	<i>Unknown</i> <sup>6</sup>	4 (12%)
Middle	28 (31%)	25 (35%)	<i>Unknown</i>	17 (50%)
Lower	20 (22%)	16 (23%)	<i>Unknown</i>	6 (18%)
Unknown <sup>5</sup>	19 (21%)	15 (21%)	<i>Unknown</i>	7 (20%)
Surgery				
Sphincter-sparing	62 (70%)	48 (68%)	43 (77%)	23 (68%)
Sphincter-ablating	27 (30%)	23 (32%)	13 (23%)	11 (32%)
Adjuvant treatment				
Pre-operative radiation +chemotherapy	18 (20%)	10 (14%)	6 (11%)	5 (15%)
Post-operative radiation +chemotherapy	31 (35%)	29 (41%)	17 (30%)	12 (35%)
Radiation only	1 (1%)	4 (6%)	0 (0%)	3 (9%)
Chemotherapy only	3 (4%)	2 (3%)	4 (7%)	1 (3%)
None	36 (40%)	26 (37%)	29 (52%)	13 (38%)

<sup>1</sup>TOTAL COMPLETERS: Completed the first and follow-up surveys<sup>2</sup>FIRST-SURVEY COMPLETER Completed the first survey only (includes those who were invited and not invited to complete the second survey)<sup>3</sup>TOTAL NON-COMPLETER Did not complete any survey<sup>4</sup>SECOND SURVEY NON-COMPLETER Was invited to complete the follow-up survey but did not participate<sup>5</sup>Although a majority CCR text records have location of tumor data, this data is not required by the CCR.<sup>6</sup>We did not have identifiers for participants who did not respond to the survey.

Table 2

Mean Initial FACT-C Scores (standard deviation) and MANOVA test statistic, Wilks Lambda P-value.

	P-value <sup>d</sup>	N <sup>2</sup>	Physical well-being	Social/Family well-being	Emotional well-being	Functional well-being	Colorectal concerns
Age	0.005						
<=65		78	20.4 (6.1)	22.4 (4.5)	18.9 (4.9)	18.9 (6.3)	19.9 (4.9)
>65		82	23.4 (4.3)	22.7 (4.6)	20.7 (3.1)	19.9 (5.4)	21.7 (4.4)
Gender	0.009						
Male		89	22.2 (5.2)	21.7 (5.0)	20.0 (3.8)	19.0 (5.8)	21.2 (4.6)
Female		71	21.6 (5.7)	23.7 (3.6)	19.7 (4.7)	20.0 (6.0)	20.3 (4.9)
Race/Ethnicity	0.19						
White		125	22.3 (5.1)	22.6 (4.3)	19.9 (3.9)	19.4 (5.7)	20.7 (4.6)
Black		8	20.8 (6.9)	22.3 (4.2)	21.0 (4.0)	20.1 (5.0)	20.0 (7.1)
Hispanic		11	21.1 (6.3)	23.3 (4.9)	20.1 (3.8)	19.3 (7.2)	23.5 (3.5)
Asian/PI		16	20.0 (7.1)	22.3 (6.1)	18.7 (6.7)	19.1 (7.4)	20.3 (5.0)
AJCC stage	0.0003						
I		53	23.9 (4.0)	21.8 (5.6)	21.0 (3.8)	20.8 (5.7)	22.1 (3.7)
II		41	21.8 (5.7)	23.3 (3.5)	20.1 (4.8)	19.5 (5.9)	20.2 (4.9)
III		56	20.9 (5.6)	23.0 (4.2)	19.4 (3.8)	18.3 (5.9)	20.1 (5.1)
IV		10	17.8 (5.8)	21.9 (3.1)	15.0 (5.5)	18.5 (5.8)	20.9 (5.5)
Tumor location	0.51						
Upper		37	21.3 (5.8)	22.6 (5.3)	19.6 (4.9)	19.5 (6.2)	20.6 (5.7)
Middle		53	21.6 (5.8)	22.7 (3.7)	19.7 (3.8)	18.1 (6.6)	20.1 (5.0)
Lower		36	20.0 (5.3)	21.9 (4.6)	19.6 (4.0)	19.9 (8.2)	20.7 (3.8)
Unknown		34	23.0 (4.7)	23.3 (4.7)	20.6 (4.3)	20.9 (5.2)	22.3 (3.9)
Surgery	0.96						
LAR <sup>3</sup>		110	22.1 (5.2)	22.8 (4.6)	20.0 (4.4)	19.6 (6.0)	20.9 (4.8)
APR <sup>4</sup>		50	21.5 (6.0)	22.1 (4.3)	19.5 (3.8)	19.1 (5.6)	20.6 (4.6)
Adjuvant Therapy	0.004						
None		62	24.0 (4.4)	22.6 (4.8)	20.9 (3.9)	20.6 (5.9)	21.8 (4.3)
Both		88	20.1 (5.7)	22.6 (4.4)	19.1 (4.2)	18.3 (5.8)	19.9 (5.0)
Some <sup>5</sup>		10	24.9 (2.3)	22.6 (4.1)	20.1 (4.6)	21.9 (4.9)	23.4 (3.0)



- <sup>1</sup> P-value for Wilks' Lambda test statistic of multivariate mean differences for the MANOVA. Significant p-values lead to post-hoc analysis (ANOVA and repeated measures)
- <sup>2</sup> Initial respondents include the 71 patients who completed only the initial survey and the 89 patients who completed both initial and follow-up surveys, for a total of 160.
- <sup>3</sup> LAR=low anterior resection
- <sup>4</sup> APR= abdominoperineal resection
- <sup>5</sup> Either chemotherapy or radiation therapy, but not both.

**Table 3**

Comparison of mean initial FACT-C scores (standard deviations) for participants who had and had not completed chemotherapy at the time of the first survey

	Physical well-being	Social/family well-being	Emotional well-being	Functional well-being	Colorectal concerns
Did not receive chemotherapy (n=67)	24.1	22.7	20.8	20.7	21.8
Completed chemotherapy					
Yes (n=51)	21.1	22.8	20.0	19.7	20.4
No (n=39)	18.9	22.0	18.1	16.9	19.4
P-value	<0.0001	0.6480	0.0065	0.0050	0.0346

\* P values describe the statistical significance of differences in HRQL outcomes between the 39 patients who had completed chemotherapy and the 51 who were receiving chemotherapy, but had not yet completed it.