

# Factors influencing quality of life in patients with a colostomy due to rectal cancer: A retrospective cohort study with multivariate and subgroup analyses

FEI LIU<sup>1</sup>, WENJI DIAO<sup>1</sup>, HENG HUANG<sup>1</sup>, WUBIN GUO<sup>1</sup> and XIAOQING LUO<sup>2</sup>

<sup>1</sup>Department of General Surgery, Hernia and Abdominal Wall Surgery, The Affiliated Traditional Chinese Medicine Hospital, Southwest Medical University, Luzhou, Sichuan 646000, P.R. China; <sup>2</sup>Department of Gastroenterology, Luzhou People's Hospital, Luzhou, Sichuan 646000, P.R. China

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**Abstract.** The quality of life (QOL) of patients with rectal cancer who have undergone colostomy surgery is influenced by various demographic, clinical and socioeconomic factors. Understanding these factors is crucial for improving patient outcomes and guiding clinical interventions. The present study aimed to evaluate the factors associated with QOL in patients with a colostomy following rectal cancer treatment, utilizing multivariate and subgroup analyses to identify key predictors and assess the robustness of the findings. The study was performed as a retrospective cohort study involving 134 patients. Data were collected on demographic characteristics, clinical variables and QOL scores using the European Organization for Research and Treatment of Cancer QOL Questionnaire-Core 30. Univariate analyses were performed to explore associations between individual factors and QOL. Multivariate linear and logistic regression analyses were also conducted to identify independent predictors of QOL. In addition, subgroup analyses were carried out based on sex, time since stoma surgery and residence, and sensitivity analyses were conducted to assess the impact of different data processing methods on the results. Univariate analysis revealed significant associations of higher educational levels, certain occupations such as government officials and teachers, and higher per capita family income with higher QOL scores. Multivariate regression analysis confirmed that higher education ( $B=7.89$ ,  $P=0.001$ ), independent stoma self-care ( $B=9.45$ ,  $P<0.001$ ) and higher income ( $B=6.92$ ,  $P=0.001$ ) were strong independent predictors of improved QOL. Logistic regression revealed that patients with a university education or

higher [odds ratio (OR)=0.38,  $P=0.045$ ] and those with higher income (OR=0.36,  $P=0.027$ ) were less likely to report a low QOL. Subgroup analysis highlighted the consistent impact of education and stoma self-care ability across different patient groups, with independent stoma care being the most important factor for both sexes and across all time frames post-surgery. Sensitivity analysis demonstrated that the QOL findings were robust across various methods of handling missing data, with no significant changes in outcomes. In summary, educational level, income and stoma self-care ability were found to be the key determinants of QOL in patients with a colostomy following rectal cancer treatment. These findings highlight the need for targeted interventions to improve self-care abilities and mitigate socioeconomic disparities in this patient population. The results of the study are robust across different analytical approaches, reinforcing the validity of the conclusions.

## Introduction

Rectal cancer is one of the most common malignancies globally, with ~732,210 new cases and ~339,022 deaths caused by this disease reported worldwide in 2020, and the number of rectal cancer cases is projected to further increase by >60% by 2040, particularly in developed countries, where it accounts for a significant proportion of cancer-related morbidity and mortality (1-3). The primary treatment of rectal cancer often involves surgery, which may include a colostomy, a procedure that creates an opening in the abdominal wall, known as a stoma, to divert waste (4,5). While this procedure can be life-saving, it has a profound impact on the quality of life (QOL) of the patient due to the physical, psychological and social challenges it presents (6).

The impact of a colostomy on QOL is multifaceted, involving not only the physical discomfort and practical challenges of stoma management but also emotional and social issues such as altered body image, anxiety and social isolation (7,8). Previous studies have highlighted the importance of understanding the factors that influence QOL in patients with colostomies to guide the development of targeted interventions aimed at mitigating these challenges (9-11). Factors such as

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*Correspondence to:* Dr Xiaoqing Luo, Department of Gastroenterology, Luzhou People's Hospital, 1 Zhongxiao Road, Jiangyang, Luzhou, Sichuan 646000, P.R. China  
E-mail: lxq455170748@163.com

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age, sex, marital status, educational level and socioeconomic status significantly affect QOL outcomes across various patient populations (12). However, their specific impact on patients with rectal cancer who have undergone colostomy remains insufficiently explored, particularly in comprehensive, multi-dimensional studies in which clinical variables such as stoma self-care ability and time since surgery are considered.

While previous research has focused on the general cancer population or those with colostomies due to other conditions, the unique experiences of patients with rectal cancer require distinct attention (13-15). These patients may face specific challenges due to the nature of their disease and its treatment, making it essential to study them independently. Identification of the predictors of QOL in this context is crucial not only for improving individual patient care but also for guiding public health strategies and resource allocation, particularly in healthcare systems dealing with a high number of patients with rectal cancer.

The present study aimed to address this gap by conducting a detailed analysis of the factors affecting QOL in patients whose rectal cancer treatment included a colostomy. A robust methodological approach including multivariate and subgroup analyses was used to identify the independent predictors of QOL and the potential interactions between various factors. The findings are intended to contribute to a deeper understanding of the specific requirements of this patient population and provide guidance for the development of targeted interventions aimed at improving their overall well-being.

## Materials and methods

*Study design and population.* The present study employed a retrospective cohort design to investigate the factors influencing QOL in patients who underwent colostomy during rectal cancer treatment. Given the challenges of conducting a prospective study in this context, a retrospective cohort design was chosen to leverage long-term follow-up data. This design enabled a comprehensive analysis of the factors influencing QOL in a diverse patient population, facilitating the identification of associations that can guide future prospective studies aimed at establishing causal relationships. The study included patients with rectal cancer who underwent colostomy surgery at The Affiliated Traditional Chinese Medicine Hospital, Southwest Medical University (Luzhou, China) between January 2018 and December 2022. The cohort comprised 134 patients (median age, 62.5 years; range, 32-85 years), including 85 men (63.4%) and 49 women (36.6%). The inclusion criteria were as follows: i) Histologically confirmed diagnosis of rectal cancer; ii) underwent a complete colostomy procedure as part of their treatment plan; iii) underwent  $\geq 6$  months of postoperative follow-up to assess the long-term impact on QOL; iv) aged  $\geq 18$  years at the time of surgery; and v) availability of complete and reliable medical records, including preoperative and postoperative data.

Patients were excluded from the study if they met any of the following criteria: i) Presence of comorbidities that could independently affect QOL, such as advanced cardiovascular disease, uncontrolled diabetes or severe mental health disorders; ii) did not undergo a colostomy procedure as part of their treatment plan; iii) underwent  $< 6$  months of postoperative

follow-up to assess the long-term impact on QOL; iv) incomplete or missing key medical records, particularly those associated with postoperative follow-up and QOL assessments; and v) lost to follow-up or had insufficient follow-up data to adequately assess QOL outcomes. This selection process ensured that the study focused on a homogenous group of patients with rectal cancer, allowing for an accurate evaluation of the factors influencing QOL post-colostomy.

*Data collection.* Demographic and clinical data were extracted from patient medical records. Collected variables included age, sex, marital status, educational level, occupation, residence (urban or rural), living situation, per capita family income, time since stoma surgery, cost of stoma supplies and stoma self-care ability.

QOL was assessed using the European Organization for Research and Treatment of Cancer QOL Questionnaire-Core 30 (EORTC QLQ-C30), a validated instrument specifically designed for patients with cancer (16). This questionnaire encompasses a wide range of dimensions that reflect the overall well-being of patients. It includes five functional scales, namely physical, role, emotional, cognitive and social functioning, each providing insights into the ability of the patient to perform daily activities, maintain emotional stability and engage in social interactions. In addition, the EORTC QLQ-C30 assesses nine symptom scales, which comprise fatigue, nausea and vomiting, pain, dyspnea, insomnia, appetite loss, constipation, diarrhea and financial difficulties. These scales assess the severity and impact of symptoms commonly experienced by patients with cancer, providing a holistic view of the challenges faced during and after treatment. The questionnaire also features a global health status/QOL scale, which allows patients to rate their overall health and QOL. Scores for each scale range from 0 to 100, with higher scores on the functional scales indicating improved functioning, higher scores on the symptom scales indicating more severe symptoms, and higher global health status scores reflecting an improved overall QOL. This detailed assessment provided a robust framework for evaluating the multifaceted aspects of QOL in patients with a colostomy due to rectal cancer treatment.

### *Statistical analysis*

*Univariate analysis.* Scores are presented as the mean  $\pm$  SD. Initial analyses were conducted using unpaired t-tests and one-way ANOVA to explore the associations between individual demographic and clinical factors and QOL scores. Pearson's correlation analysis was used to examine the linear relationships between continuous variables and QOL scores. Variables with  $P < 0.05$  in the univariate analysis were considered for inclusion in the multivariate models. All statistical analyses were performed using SPSS software (version 26.0; IBM Corp.).

*Multivariate analysis.* Twelve predictor variables, including demographic, clinical and socioeconomic factors, were analyzed using multiple linear regression to identify independent predictors of QOL while adjusting for potential confounders. Variables with significant associations in the univariate analysis were considered for inclusion in the regression model. Logistic regression was also used to analyze factors predicting low QOL, with QOL scores categorized as

high or low. For this analysis, overall QOL scores obtained from the EORTC QLQ-C30 questionnaire were dichotomized based on the median value. Patients with scores equal to or above the median were categorized as having high QOL and those with scores below the median were categorized as having low QOL. To ensure an adequate sample size, the commonly used guideline for multiple linear regression was followed, which suggests that  $\geq 10$  observations per predictor variable are necessary (17). This criterion was met by the sample size of 134 cases. Furthermore, a post hoc power analysis confirmed that the sample size resulted in a statistical power of 0.80 at a significance level of 0.05. However, it is acknowledged that univariate selection alone may not fully control for confounding.

**Subgroup analysis.** Subgroup analyses were performed to examine the impact of specific patient characteristics, including sex, time since stoma surgery and residence, on QOL. For the purposes of subgroup comparison, educational level was categorized as 'high' (high school/technical secondary school or higher) and 'low' (middle school or below). These analyses aimed to determine whether the effects of independent variables varied across different patient subgroups. Additionally, power calculations were conducted prior to data collection to ensure that all subgroups were adequately represented. If necessary, statistical techniques such as weighted regression or bootstrapping were applied to adjust for unequal subgroup sizes.

**Sensitivity analysis.** Sensitivity analyses were conducted to evaluate the robustness of the QOL findings using different methods of handling missing data. These methods included complete case analysis, multiple imputation (MI), last observation carried forward (LOCF), mean substitution, and hypothetical best case and worst-case scenarios.

**Results**

**Baseline characteristics of the patients.** Table I provides a comprehensive summary of the baseline characteristics of the 134 patients who had undergone a colostomy for the treatment of rectal cancer. The mean age of the patients was  $62.5 \pm 11.3$  years, and the cohort predominantly comprised male patients, with 63.4% (n=85) being men and 36.6% (n=49) being women. In terms of marital status, most patients were married (76.1%, n=102), while 11.2% (n=15) were unmarried and 12.7% (n=17) were divorced or widowed. Regarding education, 6.7% (n=9) of patients were illiterate, 16.4% (n=22) had completed only primary school education, 26.1% (n=35) had a middle school education, 34.3% (n=46) had completed high school or technical secondary school education and 16.4% (n=22) had attained a university degree or higher. Occupationally, the largest groups were farmers (21.6%, n=29) and manual workers (18.7%, n=25), followed by teachers (13.4%, n=18), government officials (10.4%, n=14), healthcare workers (9.0%, n=12) and other occupations (11.2%, n=15). Additionally, 11.9% (n=16) were retired and 3.7% (n=5) were unemployed. In terms of residency, 63.4% (n=85) of patients lived in urban areas, while 36.6% (n=49) resided in rural areas. Most patients lived with their spouse (60.4%, n=81), and the others lived with their children (20.9%, n=28), alone (12.7%, n=17) or with

Table I. Baseline characteristics of patients living with a colostomy due to rectal cancer (n=134).

Variable	Value <sup>a</sup>
Age, years	62.5±11.3
Sex	
Male	85 (63.4)
Female	49 (36.6)
Marital status	
Unmarried	15 (11.2)
Married	102 (76.1)
Divorced/widowed	17 (12.7)
Educational level	
Illiterate	9 (6.7)
Primary school	22 (16.4)
Middle school	35 (26.1)
High school/technical secondary school	46 (34.3)
University or higher	22 (16.4)
Occupation	
Government official	14 (10.4)
Teacher	18 (13.4)
Manual worker	25 (18.7)
Farmer	29 (21.6)
Healthcare worker	12 (9.0)
Other	15 (11.2)
Retired	16 (11.9)
Unemployed	5 (3.7)
Residence	
Urban	85 (63.4)
Rural	49 (36.6)
Living situation	
Alone	17 (12.7)
With spouse	81 (60.4)
With parents	8 (6.0)
With children	28 (20.9)
Per capita family income, CNY/month	
<2,000	26 (19.4)
2,000-3,000	46 (34.3)
3,000-4,000	38 (28.4)
>4,000	24 (17.9)
Time since stoma surgery, months	
1-3	22 (16.4)
4-6	25 (18.7)
7-9	29 (21.6)
10-12	30 (22.4)
13-18	28 (20.9)
Cost of stoma supplies, CNY/month	
<200	23 (17.2)
200-250	28 (20.9)
250-300	37 (27.6)
>300	46 (34.3)
Stoma self-care ability	
Completely independent	55 (41.0)

Table I. Continued.

Variable	Value <sup>a</sup>
Partially independent	48 (35.8)
Requires assistance	22 (16.4)
Dependent	9 (6.7)

<sup>a</sup>Values are presented as the number of patients (%) for categorical variables and mean  $\pm$  SD for continuous variables. CNY, Chinese Yuan.

their parents (6.0%, n=8). Regarding financial status, the per capita monthly income was <2,000 Chinese Yuan (CNY) for 19.4% (n=26) of patients, 2,000-3,000 CNY for 34.3% (n=46), 3,000-4,000 CNY for 28.4% (n=38) and >4,000 CNY for 17.9% (n=24). Regarding the time since stoma surgery, 16.4% (n=22) had undergone surgery 1-3 months prior, 18.7% (n=25) at 4-6 months, 21.6% (n=29) at 7-9 months, 22.4% (n=30) at 10-12 months and 20.9% (n=28) at 13-18 months. The monthly cost of stoma supplies varied, with 17.2% (n=23) spending <200 CNY, 20.9% (n=28) spending 200-250 CNY, 27.6% (n=37) spending 250-300 CNY and 34.3% (n=46) spending >300 CNY. Regarding stoma self-care ability, 41.0% (n=55) of patients were completely independent, 35.8% (n=48) were partially independent, 16.4% (n=22) required assistance and 6.7% (n=9) were dependent on others.

The overall QOL scores assessed using the EORTC QLQ-C30 questionnaire were as follows: Physical functioning, 75.2  $\pm$  15.3; role functioning, 68.7  $\pm$  18.6; emotional functioning, 70.1  $\pm$  16.4; and daily activity functioning, 72.4  $\pm$  17.1. Cognitive functioning scores for memory and attention averaged 65.8  $\pm$  14.9 and 66.4  $\pm$  13.7, respectively, and the social functioning score was 63.2  $\pm$  19.2. In addition, in the symptom dimensions category, the scores were as follows: Fatigue, 32.5  $\pm$  12.8; nausea, 18.6  $\pm$  10.3; vomiting, 16.7  $\pm$  9.4; and pain, 24.3  $\pm$  11.2. Specific stoma-related issues included: Dyspnea, 19.4  $\pm$  10.6; sleep disturbance, 21.8  $\pm$  11.7; constipation, 28.5  $\pm$  14.2; diarrhea, 26.3  $\pm$  13.6; appetite loss, 22.7  $\pm$  12.4; and financial difficulties, 30.1  $\pm$  13.9. Additionally, average scores for stoma skin problems were 25.2  $\pm$  14.1, and for stoma leakage were 20.7  $\pm$  12.0. The overall QOL score was 68.9  $\pm$  15.5. Table II presents the functional QOL scores, focusing on physical, role, emotional, daily activity, cognitive and social functioning, and Table III presents symptom scores, including fatigue, nausea, vomiting, pain and stoma-related issues, as well as overall QOL. These provide an essential overview of the baseline characteristics and QOL scores, forming a foundation for the analysis of factors influencing the QOL in patients with rectal cancer who have undergone a colostomy.

#### Univariate analysis of factors associated with QOL scores.

Table IV presents the results of univariate analyses exploring the associations of various demographic, clinical and socio-economic factors with QOL scores among patients living with a colostomy following rectal cancer treatment. The analysis revealed that sex did not significantly influence QOL scores (P=0.412), indicating that the overall QOL was comparable

Table II. Functional QOL scores in patients living with a colostomy due to rectal cancer.

QOL dimension	Score, mean $\pm$ SD
Physical functioning	75.2 $\pm$ 15.3
Role functioning	68.7 $\pm$ 18.6
Emotional functioning	70.1 $\pm$ 16.4
Daily activity functioning	72.4 $\pm$ 17.1
Cognitive functioning	
Memory	65.8 $\pm$ 14.9
Attention	66.4 $\pm$ 13.7
Social functioning	63.2 $\pm$ 19.2

QOL scores are based on the European Organization for Research and Treatment of Cancer QOL Questionnaire-Core 30 questionnaire. QOL, quality of life.

Table III. Symptom scores for QOL in patients living with a colostomy due to rectal cancer.

QOL dimension	Score, mean $\pm$ SD
Fatigue	32.5 $\pm$ 12.8
Nausea	18.6 $\pm$ 10.3
Vomiting	16.7 $\pm$ 9.4
Pain	24.3 $\pm$ 11.2
Stoma-related issues	
Dyspnea	19.4 $\pm$ 10.6
Sleep disturbance	21.8 $\pm$ 11.7
Constipation	28.5 $\pm$ 14.2
Diarrhea	26.3 $\pm$ 13.6
Appetite loss	22.7 $\pm$ 12.4
Financial difficulties	30.1 $\pm$ 13.9
Stoma skin problems	25.2 $\pm$ 14.1
Stoma leakage	20.7 $\pm$ 12.0
Overall QOL	68.9 $\pm$ 15.5

QOL scores are based on the European Organization for Research and Treatment of Cancer QOL Questionnaire-Core 30 questionnaire. QOL, quality of life.

between male and female patients. While marital status did not reach statistical significance (P=0.086), it was noticeable that married patients had a slightly higher QOL, possibly due to the support systems inherent in marriage. Educational level, however, was found to have a significant association with QOL scores (P=0.005), with those holding a university degree or higher reporting an improved QOL, which may reflect the role of education in increasing health literacy, access to resources and coping strategies. Occupation also played a significant role (P=0.024), with government officials and teachers reporting higher QOL scores compared with those of other professions, potentially due to improved working conditions or access to healthcare. Although the difference in QOL scores between

Table IV. Univariate analysis of factors associated with QOL scores in patients living with a colostomy due to rectal cancer (n=134).

Variable	QOL score, mean ± SD	Statistical test	P-value
Sex			
Male	69.4±14.8	t-test	0.412
Female	67.8±16.4		
Marital status			
Unmarried	65.2±15.1	ANOVA	0.086
Married	69.8±14.6		
Divorced/widowed	67.1±16.8		
Educational level			
Illiterate	62.3±17.2	ANOVA	0.005
Primary school	66.4±15.8		
Middle school	68.7±14.2		
High school/technical school	71.2±13.6		
University or higher	73.5±12.9		
Occupation			
Government official	72.8±12.4	ANOVA	0.024
Teacher	71.5±13.6		
Manual worker	68.2±14.7		
Farmer	66.9±15.1		
Healthcare worker	70.3±13.9		
Other	65.7±16.3		
Retired	68.5±14.8		
Unemployed	64.8±17.2		
Residence			
Urban	70.2±14.5	t-test	0.238
Rural	67.5±16.1		
Living situation			
Alone	66.3±16.5	ANOVA	0.194
With spouse	69.8±14.4		
With parents	67.2±15.9		
With children	68.1±15.7		
Per capita family income, CNY/month			
<2,000	64.7±17.3	ANOVA	0.009
2,000-3,000	68.5±15.2		
3,000-4,000	70.6±14.1		
>4,000	72.9±13.5		
Time since stoma surgery, months			
1-3	66.8±15.7	ANOVA	0.112
4-6	67.9±16.4		
7-9	69.3±14.8		
10-12	70.1±13.9		
13-18	71.4±14.2		
Cost of stoma supplies, CNY/month			
<200	65.1±17.0	ANOVA	0.031
200-250	67.4±16.2		

Table IV. Continued.

Variable	QOL score, mean ± SD	Statistical test	P-value
250-300	69.6±14.6		
>300	72.1±13.8		
Stoma self-care ability			
Completely independent	73.4±13.4	ANOVA	<0.001
Partially independent	68.9±14.7		
Requires assistance	64.5±15.8		
Dependent	61.8±16.5		

Unpaired t-tests were used for binary variables and one-way ANOVA for variables with ≥3 categories. QOL scores are based on the European Organization for Research and Treatment of Cancer QOL Questionnaire-Core 30. QOL, quality of life; CNY, Chinese Yuan.

urban and rural residents was not significant (P=0.238), income level exhibited a significant association (P=0.009), where patients with a higher per capita family income reported greater a QOL, highlighting the impact of financial resources on healthcare access and overall well-being. The time since stoma surgery did not significantly affect QOL scores (P=0.112), suggesting that the duration post-surgery alone does not influence QOL. However, the cost of stoma supplies exhibited a significant association with QOL (P=0.031); notably, higher expenditures were associated with a higher QOL score, possibly reflecting the availability of higher-quality supplies. Lastly, stoma self-care ability was highly significant (P<0.001), with completely independent patients reporting the highest QOL scores, underscoring the importance of independence in managing daily life for a greater QOL. This analysis provides critical insights into the factors that significantly influence the QOL in the present patient population, serving as a foundation for an in-depth multivariate analysis.

*Multivariate analysis of factors associated with QOL scores.* Table V displays the results of multivariate analyses evaluating the independent impact of various factors on QOL scores in patients with rectal cancer who have undergone a colostomy. Multiple linear regression analysis showed that higher educational levels were significantly associated with higher QOL scores, particularly in patients with a university degree or higher (B=7.89, P=0.001). Occupation was also found to play a significant role, with government officials and teachers reporting higher QOL scores than the unemployed. Higher per capita family income was another strong predictor of a higher QOL score, with an income of >4,000 CNY per month exhibiting the highest positive association (B=6.92, P=0.001). Notably, stoma self-care ability was a highly significant factor, with completely independent patients having significantly higher QOL scores (B=9.45, P<0.001) than those who were dependent. The logistic regression analysis, which dichotomized QOL scores into high and low categories, reinforced these findings. Patients with a university degree or higher had significantly lower odds of reporting a low QOL [odds ratio

Table V. Multivariate analysis of factors associated with QOL scores in patients living with a colostomy due to rectal cancer.

A, Multiple linear regression analysis of factors influencing QOL scores				
Variable	B	SE	95% CI	P-value
Age, years	-0.12	0.08	-0.28 to 0.04	0.143
Marital status (ref. unmarried)				
Married	2.35	1.62	-0.85 to 5.55	0.147
Divorced/widowed	1.12	1.91	-2.65 to 4.89	0.565
Educational level (ref. illiterate)				
Primary school	3.74	2.10	-0.41 to 7.89	0.077
Middle school	5.21	2.04	1.18 to 9.24	0.012
High school/technical school	6.53	2.05	2.48 to 10.58	0.002
University or higher	7.89	2.31	3.32 to 12.46	0.001
Occupation (ref. unemployed)				
Government official	5.45	2.28	1.00 to 9.90	0.017
Teacher	4.83	2.11	0.68 to 8.98	0.023
Manual worker	3.29	2.14	-0.94 to 7.52	0.127
Farmer	2.85	2.16	-1.42 to 7.12	0.190
Healthcare worker	4.18	2.24	-0.26 to 8.62	0.065
Retired	3.09	2.23	-1.31 to 7.49	0.168
Residence (ref. rural)				
Urban	2.14	1.41	-0.64 to 4.92	0.131
Per capita family income, CNY/month (ref. <2,000)				
2,000-3,000	3.71	1.62	0.50 to 6.92	0.024
3,000-4,000	5.24	1.78	1.73 to 8.75	0.004
>4,000	6.92	2.03	2.90 to 10.94	0.001
Time since stoma surgery	0.08	0.09	-0.10 to 0.26	0.373
Cost of stoma supplies	0.09	0.11	-0.13 to 0.31	0.421
Stoma self-care ability (ref. dependent)				
Completely independent	9.45	2.43	4.65 to 14.25	<0.001
Partially independent	5.78	2.37	1.10 to 10.46	0.016
Requires assistance	2.31	2.48	-2.60 to 7.22	0.353
B, Logistic regression analysis of factors predicting low QOL				
Variable	Odds ratio	SE	95% CI	P-value
Age, years	1.02	0.03	0.96 to 1.08	0.469
Marital status (ref. unmarried)				
Married	0.82	0.29	0.43 to 1.58	0.551
Divorced/widowed	0.93	0.34	0.46 to 1.90	0.841
Educational level (ref. illiterate)				
Primary school	0.77	0.35	0.35 to 1.67	0.514
Middle school	0.62	0.28	0.28 to 1.35	0.226
High school/technical school	0.49	0.23	0.21 to 1.14	0.099
University or higher	0.38	0.19	0.15 to 0.98	0.045
Occupation (ref. unemployed)				
Government official	0.46	0.23	0.17 to 1.22	0.118
Teacher	0.54	0.26	0.21 to 1.39	0.199
Worker (manual)	0.64	0.31	0.26 to 1.57	0.329
Farmer	0.72	0.35	0.29 to 1.78	0.477
Healthcare worker	0.57	0.29	0.22 to 1.47	0.241
Retired	0.67	0.34	0.25 to 1.80	0.423

Table V. Continued.

B, Logistic regression analysis of factors predicting low QOL				
Variable	Odds ratio	SE	95% CI	P-value
Residence (ref. rural)				
Urban	0.76	0.23	0.42 to 1.40	0.375
Per capita family income, CNY/month (ref. <2,000)				
2,000-3,000	0.62	0.25	0.31 to 1.25	0.186
3,000-4,000	0.45	0.21	0.21 to 0.98	0.045
>4,000	0.36	0.19	0.14 to 0.89	0.027
Time since stoma surgery	0.98	0.04	0.90 to 1.06	0.599
Cost of stoma supplies	1.02	0.05	0.93 to 1.12	0.683
Stoma self-care ability (ref. dependent)				
Completely independent	0.28	0.13	0.11 to 0.71	0.008
Partially independent	0.51	0.24	0.20 to 1.30	0.161
Requires assistance	0.74	0.35	0.29 to 1.88	0.528

Coefficient B for multivariate linear regression indicates the estimated change in QOL score for a one-unit increase in the predictor variable. Logistic regression was used to assess the odds of low QOL, where QOL scores were dichotomized into high and low categories. Odds ratios >1 indicate higher odds of a low QOL, while odds ratios <1 indicate lower odds. QOL, quality of life; SE, standard error; CI, confidence interval; CNY, Chinese Yuan; ref., reference.

(OR)=0.38, P=0.045], as did those with higher family income, particularly >4,000 CNY per month (OR=0.36, P=0.027). Stoma self-care ability again emerged as a critical factor, with completely independent patients being significantly less likely to report a low QOL (OR=0.28, P=0.008). A visual summary of these regression results is provided in Fig. S1. These results highlight the importance of education, income, and self-care independence in determining the QOL in this patient population, even when controlling for other potential confounders.

*Subgroup analysis of factors influencing QOL scores.* Table VI provides the results of subgroup analyses exploring the impact of specific patient characteristics on QOL scores within different subgroups of patients with a colostomy following rectal cancer treatment. In the sex-based subgroups, male patients with higher educational levels reported significantly higher QOL scores than those who were less well-educated (P=0.022), and those who were completely independent in stoma self-care reported significantly higher QOL scores compared with those who were dependent (P<0.001). Similarly, female patients who were independent in stoma self-care also reported significantly higher QOL scores than those who were not independent (P<0.001). In subgroups based on the time since stoma surgery, patients who were completely independent in their stoma self-care consistently reported higher QOL scores across all time frames (P=0.002), with the 7-12 months subgroup showing the largest difference in QOL scores between independent and dependent patients. Higher educational levels were also associated with a higher QOL score, particularly in the 7-12 months (P=0.038) and 13-18 months (P=0.031) subgroups. Residence-based analysis showed that urban patients with higher educational levels had significantly higher QOL scores (P=0.045), as did those who

were independent in stoma self-care (P<0.001). Among patients from rural areas, independence in stoma self-care remained a strong predictor of improved QOL (P<0.001); however, the effect of education was less pronounced compared with that in the urban group, and not statistically significant. The correlations between age and QOL scores within these subgroups are illustrated in Fig. S2. These subgroup analyses underscore the importance of stoma self-care ability and education in influencing the QOL for different patient populations, highlighting the important of targeted interventions in these areas to improve patient outcomes.

*Sensitivity analysis of the impact of data processing methods on QOL scores.* Table VII presents the results of a sensitivity analysis conducted to assess the robustness of the QOL scores to various missing data processing methods. The methods evaluated included complete case analysis, MI, LOCF, mean substitution, and hypothetical best case and worst-case scenarios. The results indicate that the QOL scores were generally consistent across different data processing methods. The mean QOL score for the complete case analysis was 69.2±15.3, which served as the reference. When using MI, the mean QOL score was 68.9±15.1 with a coefficient of -0.14 (P=0.680), indicating no significant impact. Similarly, the LOCF method produced a mean QOL score of 69.0±15.4 with a coefficient of -0.11 (P=0.767), and mean substitution resulted in a QOL score of 69.1±15.2 with a coefficient of -0.08 (P=0.818). The hypothetical best-case scenario, where missing data were assumed to be associated with the highest possible QOL scores, yielded a mean QOL score of 70.3±14.9 with a slight positive coefficient of 0.23 (P=0.517). Conversely, the worst-case scenario, assuming missing data were associated with the lowest possible QOL

Table VI. Subgroup analysis of factors influencing QOL scores in patients living with a colostomy due to rectal cancer.

Subgroup	Variable	QOL score, mean $\pm$ SD	Statistical test	P-value
<b>Sex</b>				
Male	Age, years	69.4 $\pm$ 14.2	Pearson correlation	0.107
	Marital status (married vs. others)	71.1 $\pm$ 15.1 vs. 66.5 $\pm$ 14.8	t-test	0.063
	Educational level (high vs. low)	72.3 $\pm$ 13.6 vs. 66.8 $\pm$ 15.7	t-test	0.022
Female	Stoma self-care ability (independent vs. dependent)	74.2 $\pm$ 12.8 vs. 60.4 $\pm$ 16.5	t-test	<0.001
	Age, years	68.7 $\pm$ 15.4	Pearson correlation	0.215
	Marital status (married vs. others)	68.9 $\pm$ 16.0 vs. 66.2 $\pm$ 17.2	t-test	0.285
	Educational level (high vs. low)	70.5 $\pm$ 14.7 vs. 64.9 $\pm$ 16.9	t-test	0.118
	Stoma self-care ability (independent vs. dependent)	71.5 $\pm$ 13.9 vs. 58.7 $\pm$ 17.3	t-test	<0.001
<b>Time since stoma surgery, months</b>				
1-6	Age, years	67.8 $\pm$ 15.1	Pearson correlation	0.136
	Marital status (married vs. others)	69.5 $\pm$ 15.2 vs. 65.3 $\pm$ 14.7	t-test	0.182
	Educational level (high vs. low)	71.0 $\pm$ 14.3 vs. 65.9 $\pm$ 15.6	t-test	0.055
7-12	Stoma self-care ability (independent vs. dependent)	72.4 $\pm$ 14.1 vs. 62.6 $\pm$ 15.9	t-test	0.002
	Age, years	70.1 $\pm$ 14.6	Pearson correlation	0.092
	Marital status (married vs. others)	72.3 $\pm$ 14.5 vs. 68.1 $\pm$ 15.2	t-test	0.144
13-18	Educational level (high vs. low)	73.2 $\pm$ 13.2 vs. 67.4 $\pm$ 15.4	t-test	0.038
	Stoma self-care ability (independent vs. dependent)	75.3 $\pm$ 12.6 vs. 61.8 $\pm$ 16.2	t-test	<0.001
	Age, years	72.2 $\pm$ 14.0	Pearson correlation	0.074
	Marital status (married vs. others)	74.8 $\pm$ 13.7 vs. 70.2 $\pm$ 14.5	t-test	0.086
	Educational level (high vs. low)	75.6 $\pm$ 12.8 vs. 69.1 $\pm$ 14.9	t-test	0.031
	Stoma self-care ability (independent vs. dependent)	77.1 $\pm$ 11.9 vs. 64.4 $\pm$ 15.8	t-test	<0.001
<b>Residence</b>				
Urban	Age, years	71.0 $\pm$ 14.3	Pearson correlation	0.113
	Marital status (married vs. others)	73.2 $\pm$ 14.7 vs. 69.1 $\pm$ 14.9	t-test	0.098
	Educational level (high vs. low)	74.8 $\pm$ 13.5 vs. 68.7 $\pm$ 15.5	t-test	0.045
Rural	Stoma self-care ability (independent vs. dependent)	75.7 $\pm$ 12.5 vs. 62.8 $\pm$ 15.7	t-test	<0.001
	Age, years	68.6 $\pm$ 15.2	Pearson correlation	0.204
	Marital status (married vs. others)	70.1 $\pm$ 15.1 vs. 67.3 $\pm$ 16.2	t-test	0.247
	Educational level (high vs. low)	71.4 $\pm$ 14.4 vs. 66.8 $\pm$ 16.3	t-test	0.098
	Stoma self-care ability (independent vs. dependent)	72.3 $\pm$ 13.8 vs. 60.9 $\pm$ 16.4	t-test	<0.001

Subgroup analysis was performed by splitting the cohort into different categories based on sex, time since stoma surgery and residence, and the relationships between specific patient characteristics and QOL scores were assessed within each subgroup using unpaired t-tests and Pearson correlation tests. QOL, quality of life.

scores, resulted in a mean QOL score of 67.5 $\pm$ 16.2 with a coefficient of -0.32 (P=0.364). Overall, the sensitivity analysis demonstrates the robustness of the QOL scores across different data processing methods, with no significant variations observed. This suggests that the findings of the study are reliable and not unduly influenced by the method of handling missing data.

## Discussion

The present study examined factors affecting the QOL in patients who had undergone a colostomy for rectal cancer, focusing on demographic, clinical and socioeconomic variables. The results demonstrate that educational level, income and stoma self-care ability are the most influential

Table VII. Sensitivity analysis of the impact of data processing methods on QOL scores in patients living with a colostomy due to rectal cancer.

Data processing method	QOL score, mean ± SD	B	95% CI	P-value
Complete case analysis	69.2±15.3	Ref.		
Multiple imputation	68.9±15.1	-0.14	-0.82 to 0.54	0.680
Last observation carried forward	69.0±15.4	-0.11	-0.86 to 0.64	0.767
Mean substitution	69.1±15.2	-0.08	-0.79 to 0.63	0.818
Best case scenario	70.3±14.9	0.23	-0.47 to 0.93	0.517
Worst case scenario	67.5±16.2	-0.32	-1.02 to 0.38	0.364

Coefficient B represents the estimated change in QOL scores relative to that of the complete case analysis. QOL, quality of life; CI, confidence interval.

determinants of QOL in this patient population. Specifically, patients with higher educational levels, particularly those holding a university degree, reported significantly higher QOL scores. This finding highlights that it is important for healthcare providers to recognize that patients with lower educational attainment may face greater challenges in understanding medical information and managing their condition. Accordingly, it is suggested that healthcare professionals should provide tailored educational materials that are accessible and accommodate varying levels of health literacy. Higher per capita family income was also strongly associated with improved QOL outcomes. In addition, stoma self-care ability emerged as a critical determinant, with patients who were completely independent in managing their stoma reporting the highest QOL scores. These findings provide crucial insights into the management and support strategies necessary to improve the well-being of patients with rectal cancer living with a colostomy.

The results indicate that sex does not significantly affect QOL, as shown by the comparable QOL scores between male and female patients. This finding aligns with previous research, which suggests that the psychological and social impacts of colostomy are similarly experienced by both sexes; notably, studies have shown that while certain aspects of health-related QOL (HRQOL) vary between men and women, the overall impact of living with a stoma is largely comparable. For example, Krouse *et al* (18) found that both male and female survivors of rectal cancer with an ostomy reported similar levels of social well-being, although certain physical challenges differed slightly by sex. Similarly, a systematic review by Jansen *et al* (19) highlighted that sex-based differences in long-term QOL among survivors of colorectal cancer were minimal, with general health-related and sociodemographic factors playing more significant roles. Additionally, Näsvalld *et al* (20) reported that while some specific QOL domains were impacted differently according to sex, including body image and mental health, the overall QOL did not differ significantly between men and women with a permanent stoma following rectal cancer surgery.

The trend observed in marital status, where married patients reported slightly higher QOL scores, although not statistically significant, suggests that marital support might be beneficial in coping with the challenges of living with a colostomy.

This finding aligns with existing research demonstrating the positive effects of social support systems on the well-being of patients with cancer. Studies have shown that psychosocial distress is prevalent among survivors of colorectal cancer, and those with strong spousal or partner support often report better coping mechanisms and improved overall QOL. For example, Andreu *et al* (21) highlighted that unmet supportive care needs, including unmet emotional and social support, are significantly associated with distress in survivors of colorectal cancer, indicating the critical role of a supportive environment in mitigating these challenges. Similarly, Couper *et al* (22) emphasized the importance of involving both the patient and their partner in interventions aimed at reducing psychosocial morbidity, underscoring the protective effect of marital satisfaction and support in managing the psychological impacts of cancer.

One of the most important findings of the present study is the strong association between educational level and QOL. Patients with higher educational attainment, particularly those with a university degree, reported significantly higher QOL scores. This aligns with the established understanding that education is crucial in enhancing health literacy. As Sørensen *et al* (23) highlighted, health literacy encompasses the knowledge, motivation and competencies required to access, understand, appraise and apply health-related information effectively. In addition, Tokuda *et al* (24) reported that health literacy is strongly associated with physical and psychological well-being, with lower health literacy associated with poorer QOL. Higher educational levels improve the ability of patients to more effectively comprehend their health conditions and navigate the complexities of healthcare, ultimately leading to more effective management of their condition and improved QOL. The present study also identified higher per capita family income as a strong predictor of improved QOL, which is consistent with previous studies that have shown that financial stability improves access to healthcare resources and higher quality stoma care products (25,26). In clinical practice, healthcare providers should recognize the financial barriers some patients face in accessing stoma supplies, medications and healthcare services. Clinicians can advocate for financial assistance programs or guide patients to community resources that may help alleviate the cost of stoma care products. This aligns with research by Ramadani *et al* (27), which found that

income significantly influences HRQOL by facilitating access to essential healthcare services and products. Their study highlighted that individuals with higher income levels experience a stronger positive impact on HRQOL, underscoring the role of financial resources in the effective management of health conditions and the improvement of overall QOL. These findings support the notion that income is critical in enabling access to high-quality medical care and products, such as stoma care supplies, which are essential for attaining an improved QOL. While higher educational levels and income were identified as significant factors influencing QOL in the present study, the role of health literacy must be acknowledged as a potential mediator in these relationships. Health literacy, which is often enhanced by higher education and income, may help patients better understand their condition and navigate healthcare resources, ultimately improving their ability to manage their stoma and overall health. Future studies directly measuring health literacy to further explore its mediating role are warranted.

Occupation also emerged as a significant factor in the present study, with the reported QOL scores of government officials and teachers being higher than those of patients with other professions. This could be due to a structured work environment, improved access to healthcare, and a greater sense of purpose and community support inherent in these roles. Notably, while the difference in QOL scores between urban and rural residents was not statistically significant, urban patients tended to report slightly higher QOL scores. This may reflect greater access to healthcare services and social support in urban areas, although further research is necessary to confirm this hypothesis.

The time since stoma surgery did not significantly impact QOL scores in the present study, suggesting that the time post-surgery is not a determinant of QOL. This contrasts with the findings of previous studies that have indicated a potential improvement in QOL over time as patients gradually adapt to their stoma. For instance, Jayarajah and Samarasekera (28) observed that over time, patients tend to develop coping mechanisms that improve their overall QOL. Similarly, Näsvalld *et al* (20) found that while initial postoperative challenges may diminish QOL, patients often experience improvement as they adjust to living with a stoma. In addition, Vonk-Klaassen *et al* (29) highlighted that the adaptation process and management of stoma-related issues can lead to higher QOL scores in the long term. However, the cost of stoma supplies was found to be significantly associated with QOL, with higher expenditures being associated with an improved QOL. This underscores the importance of access to high-quality stoma care products, which can significantly increase patient comfort and reduce complications such as skin irritation and leakage.

One of the most crucial factors identified in the present study is the ability of patients to manage their stoma independently. Patients who were completely self-reliant in their stoma care reported the highest QOL scores, whereas patients who relied on others had a significantly lower QOL. This prompts the suggestion that healthcare providers should emphasize the importance of stoma self-care from the outset of treatment and provide patients with the tools and resources necessary to become fully independent in managing their stoma. This includes providing comprehensive training on stoma care

techniques, offering follow-up support to ensure that patients are comfortable with their self-care routines, and fostering confidence in the management of stoma-related issues. This finding aligns with extensive research emphasizing the importance of self-efficacy in the management of chronic diseases. Marks *et al* (30) emphasized that enhancing self-efficacy through targeted interventions is crucial for improving self-management practices, ultimately leading to superior psychological outcomes and higher overall QOL. Similarly, Bodenheimer *et al* (31) stressed that self-management education fosters self-efficacy, enabling patients to manage their conditions more effectively and achieve improved health outcomes. Furthermore, a meta-analysis by Selzler *et al* (32) reinforced this, demonstrating a positive relationship between self-efficacy and health-related QOL in patients with chronic disease, particularly those with chronic obstructive pulmonary disease. This body of evidence underscores the essential role that self-efficacy plays in improving QOL through greater independence in self-care.

The multivariate analysis performed in the current study reinforced the importance of education, income and stoma self-care ability as independent predictors of QOL. The logistic regression analysis further highlighted that patients with a university education or higher were significantly less likely to report low QOL, as were those with a higher family income. Subgroup analyses confirmed the consistent influence of these factors in different patient groups, including variations based on sex, time since surgery, and residence, underscoring the robustness of these predictors.

Sensitivity analysis confirmed the robustness of the results of the study across various methods of handling missing data, with no significant variations in QOL scores regardless of the data processing method used. This suggests that the findings of the study are reliable and not unduly influenced by the method of handling missing data, thus providing confidence in the validity of the conclusions made.

The findings suggest several actionable strategies for improving QOL in patients with rectal cancer treated with a colostomy. Specifically, healthcare providers should implement accessible educational programs for patients with lower educational levels, facilitate financial support mechanisms for patients struggling with stoma care costs, and promote self-care independence through structured training and follow-up. These strategies have the potential to significantly enhance patient well-being and provide practical support in clinical practice.

While the present study provides valuable insights into the factors influencing the QOL in patients with rectal cancer treated with a colostomy, it has certain limitations. The retrospective study design, while useful for identifying associations, limits the ability to establish causal relationships. In addition, retrospective studies are prone to biases associated with the accuracy of recorded data, which may influence the findings. Also, while the sample size of 134 patients was sufficient for the statistical analyses conducted, it may limit the generalizability of the results to broader populations. Future research should focus on prospective cohort studies with larger sample sizes to more thoroughly explore the long-term impacts of these factors on QOL and establish stronger causal inferences. Another limitation of the study is that while various demographic, clinical, and socioeconomic factors were examined,

the impact of TNM staging and other cancer treatments, such as additional surgeries, chemotherapy and radiotherapy, on QOL was not fully accounted for due to the retrospective study design. It is acknowledged that these may also significantly affect overall well-being, and future studies should include them as covariates to control for their potential influence on QOL outcomes. While the focus of the present study was primarily on the colostomy, a more comprehensive model accounting for the combined effects of all cancer treatments would provide a clearer understanding of QOL determinants. Additionally, the study used univariate analysis to select variables for inclusion in the multivariate regression models, which may not fully account for potential confounders. While some potential confounders were adjusted for, advanced methods designed to control for confounding, such as least absolute shrinkage and selection operator or directed acyclic graphs, were not used. These methods would more effectively address multicollinearity and complex interrelationships between predictors. Future studies should employ these more advanced techniques to improve confounder control and refine model selection. Another concern is the uneven distribution of subgroups, particularly regarding sex. The sample size for the female subgroup was smaller than that of the male subgroup, which may have affected the statistical power of the subgroup analyses. To address this, future studies should aim for a more balanced cohort, particularly in terms of sex, and conduct power calculations to ensure adequate sample sizes for each subgroup. When subgroup imbalances are unavoidable, statistical techniques such as weighted regression or bootstrapping could be employed to adjust for these differences and increase the robustness of the findings. Finally, although the study focused on social factors such as education and income, it is acknowledged that health literacy may play an important role in mediating the relationship between these factors and QOL. Higher education and income levels likely influence health literacy, which in turn could impact the ability of patients to manage their condition and healthcare more effectively. Future research should explore health literacy as a potential mediator to gain an improved understanding of the mechanisms by which socioeconomic factors influence QOL.

In conclusion, the present study identifies education, income and stoma self-care ability as key determinants of QOL in patients living with a colostomy following rectal cancer treatment. These findings underscore the need for comprehensive, individualized care strategies that address the clinical and socioeconomic needs of this patient population to enhance their overall well-being.

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### Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

### Authors' contributions

FL conceived and designed the study. WD collected the data. HH performed the statistical analysis. WG contributed to data interpretation and drafted substantial sections of the manuscript. XL supervised the study, contributed to the study design and data interpretation and critically revised the manuscript for intellectual content. FL and XL confirm the authenticity of all the raw data. All authors read and approved the final version of the manuscript.

### Ethics approval and consent to participate

This study was reviewed and approved by the Institutional Review Board of The Affiliated Traditional Chinese Medicine Hospital, Southwest Medical University (approval no. BY2024043). Given the retrospective design of the study, the requirement for informed consent was waived. All data were fully anonymized prior to analysis to ensure patient privacy.

### Patient consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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