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Fertility Concerns and Decision-Making Influences Among Young and Middle-Aged Patients with Colorectal Cancer: A Multi-Center Mixed-Methods Study

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Abstract

Background

The increasing incidence of colorectal cancer among younger individuals has made fertility concerns a significant issue requiring clinical and psychosocial support for middle-aged and young patients. Fertility anxieties not only lead to psychological distress but also influence reproductive decision-making. Current systematic research remains limited, particularly lacking mixed-method studies combining quantitative and qualitative approaches to elucidate the complex psychological mechanisms and influencing factors.

Methods

Employing a mixed-methods design, this study systematically examined the prevalence and influencing factors of fertility concerns among young and middle-aged colorectal cancer patients. A cross-sectional questionnaire survey was first conducted. Based on quantitative findings, representative cases were selected for semi-structured in-depth interviews. Descriptive statistics were combined with thematic analysis to gain deeper insights into patients' fertility anxieties and decision-making challenges.

Results

Fertility concerns among young and middle-aged colorectal cancer patients correlated with age, educational attainment, and tumour stage. They exhibited a significant positive correlation with fertility intentions and a significant negative correlation with social support. Qualitative analysis identified three themes: causes, manifestations, and impacts.

Conclusion

This mixed-methods study indicates that clinicians should enhance fertility knowledge dissemination, implement early psychological interventions, and facilitate the establishment of family and social support networks to alleviate fertility pressures and reduce fertility concerns among young and middle-aged colorectal cancer patients.

Background

Colorectal cancer ranks among the most prevalent malignancies globally. According to the World Health Organisation's International Agency for Research on Cancer global cancer statistics, 1.93 million new colorectal cancer cases were diagnosed worldwide in 2020, placing it third in incidence and second in mortality among all cancers[1].Notably, significant gender heterogeneity exists in colorectal cancer incidence: globally, age-standardized incidence rates persistently exceed those in women, with a male-to-female incidence ratio of approximately 1.2–1.5:1. The gender incidence ratio in Asia (1.38) is markedly higher than in other continents[2,3].In the colorectal cancer risk scoring criteria published by the Chinese Centre for Disease Control and Prevention, being male is explicitly listed as a risk factor (1 point for males, 0 points for females)[4]. The latest disease burden survey findings indicate a significant increase in colorectal cancer risk among individuals under 50 years old over the past two decades, with an annual growth rate of 2.2%, far exceeding the 1% growth rate observed in the 50–64 age group[5].The proportion of young patients among those affected in Asian countries such as China, South Korea, and Japan has also risen annually[6]. The 2024 China Cancer Incidence and Mortality Report published by the National Cancer Centre of China indicates that the average age of colorectal cancer diagnosis in China has decreased from approximately 65 years in the last century to 55 years, with young and middle-aged patients aged 18–45 accounting for nearly 15–20% of cases[7].

This cohort of young and middle-aged individuals is at the peak of their reproductive years. The conflict between their fertility aspirations and cancer-related reproductive concerns is particularly pronounced against the backdrop of China's low fertility society.Data from the National Bureau of Statistics indicates that China's birth cohort in 2023 numbered only 9.02 million, with the birth rate dropping to 6.39‰ – a historic low[8]. For young and middle-aged colorectal cancer patients, the disease itself and its comprehensive treatments – including surgery, chemotherapy, and radiotherapy – not only pose direct threats to life and health but also exert negative impacts across multiple dimensions: quality of life, psychological state, and future life planning[9].Among these impacts, reproductive concerns rank as the second most significant issue after survival anxiety[10]. Defined as persistent worries regarding reproductive function maintenance and child-rearing capabilities, these concerns encompass fertility levels, health risks to oneself and offspring, and parenting capacity[11].In simple correlation analyses, existing research has confirmed that high levels of reproductive concerns among general cancer patients or female populations can induce psychological disorders such as depression and anxiety. This directly reduces treatment adherence and may even lead patients to make suboptimal medical decisions, such as delaying standard treatment or abandoning fertility planning, ultimately affecting disease prognosis[12,13].Authoritative clinical guidelines have explicitly prioritised this issue: the European Society for Medical Oncology Clinical Practice Guideline on Cancer, Pregnancy and Fertility states that unresolved fertility concerns impact patients' treatment decisions and prognosis[14];The American Society of Clinical Oncology 2025 updated Clinical Practice Guideline on Fertility Preservation in Cancer Patients explicitly recommends that clinicians should assess reproductive risks and provide counselling at diagnosis and during follow-up, with fertility preservation options discussed prior to cancer treatment initiation [15].

Existing literature on fertility concerns among colorectal cancer patients exhibits three core gaps, none of which address the central perspective of this study, thereby leaving clear scope for innovation: Firstly, research subjects exhibit significant gender bias,predominantly focusing solely on female patients. Systematic reviews and qualitative studies concerning female patients with early-onset colorectal cancer have only preliminarily identified that their fertility concerns centre on: - Decreased ovarian reserve function caused by antineoplastic treatments - Menstrual irregularities - Premature menopause - Potential teratogenic risks of chemotherapy drugs to foetuses [10] Moreover, only a few influencing variables have been identified, such as depressive mood and lack of social support[16],Secondly, research concerning male patients exhibits inherent limitations. Existing sparse reports remain confined to physiological reproductive impairment, mentioning ejaculatory dysfunction caused by pelvic surgery nerve damage, damage to spermatogenic cells by chemotherapeutic agents such as fluorouracil and oxaliplatin, and the potential recovery of spermatogenesis in some patients 6–12 months post-chemotherapy[10].yet none have advanced to psychological assessments or interventions for fertility concerns. Furthermore, there is scant attention to the significantly lower willingness among male patients to initiate fertility-related discussions. Only a minority of clinical staff proactively raise fertility risks and preservation options throughout treatment, leaving the core mechanisms of fertility anxiety and its pathways to health outcomes in an academic blind spot[17].Thirdly, existing research suffers from dual deficiencies in population and context alignment: it neither precisely targets the core reproductive age cohort of 18–45 year-olds—whose fertility needs are most urgent and whose clinical characteristics exhibit the most pronounced conflict with anticancer treatments—nor does it integrate China's low fertility societal backdrop with local clinical realities;Moreover, no study has systematically examined the overall distribution of fertility concerns within this cohort or its profound cascading effects on treatment adherence, disease prognosis, and long-term quality of life[18].

To date, no study has employed mixed-methods research to integrate qualitative and quantitative data, comprehensively analysing the multidimensional characteristics of fertility concerns among young and middle-aged colorectal cancer patients and their gender-specific mechanisms influencing medical decision-making.Addressing these research gaps and aligning with national fertility policy directives, this study employs a mixed-methods approach to systematically investigate the current status, influencing factors, and gender-specific characteristics of fertility concerns among young and middle-aged colorectal cancer patients. It further aims to elucidate the underlying mechanisms governing their role in medical decision-making and fertility planning.

Design and methods

This study employs a mixed-methods design for a cross-sectional investigation. The quantitative component utilises questionnaire surveys, while the qualitative component is conducted through semi-structured interviews.The mixed-methods approach combines the objectivity of quantitative research with the depth of qualitative inquiry, facilitating a more comprehensive understanding of patients' fertility concerns. This enables a thorough analysis of factors influencing fertility decisions among young and middle-aged colorectal cancer patients, allowing research findings to mutually corroborate and complement each other. This approach addresses the limitations of single-method studies, enhancing the reliability and credibility of the research outcomes.

Quantitative Research

Participants:

Convenience sampling was employed to recruit middle-aged and young colorectal cancer patients admitted to two tertiary general hospitals and one tertiary specialist hospital in Tianjin between December 2025 and January 2026. Inclusion criteria: (1) Patients with primary colorectal cancer meeting the pathological diagnostic criteria of the Chinese Society of Clinical Oncology[19]; (2) Aged 18–50 years;(3) Normal fertility status without infertility symptoms prior to diagnosis; (4) Conscious patients capable of autonomous communication without other psychiatric disorders; (5) Participants who understood the study content and voluntarily enrolled. Exclusion criteria: (1) Patients diagnosed with infertility prior to colorectal cancer diagnosis; (2) Patients with severe complications or significant organ dysfunction; (3) Patients with psychiatric disorders unable to communicate effectively;(4) Participants already enrolled in similar studies. For factor analysis, the sample size should be at least 5–10 times the number of study variables[20]. With 21 variables and accounting for 20% attrition, a minimum sample size of 126 cases is required. This study received hospital ethics approval (IRB2025-901-01), and all participants provided informed consent.

Outcome measures

(1) General Information Questionnaire.This questionnaire was designed by the researchers. The general information section was developed based on relevant literature, clinical practice, and expert opinions. It covers demographic characteristics and experiences and attitudes related to screening, including the patient's gender, age, place of residence, educational attainment, marital status, occupation, average monthly household income, method of medical expense payment, number and gender of children, current tumour stage, treatment modality, family history, fertility intentions, knowledge of fertility information and assisted reproductive technologies.

(2) The Reproductive Concerns After Cancer Scale-7 (RCAC-7). This scale was revised by Chen Yufen et al.[21]and comprises seven items comprehensively covering seven core aspects: readiness for reproduction, assessment of reproductive potential, self-perceived health status, spousal awareness, acceptance of infertility, concerns about offspring health, and self-evaluation of parenting capacity.The RCAC-7 employs a 5-point Likert scale ranging from "Strongly disagree" (1 point) to "Strongly agree" (5 points), yielding a total score between 7 and 35. Higher scores indicate greater reproductive anxiety. The scale demonstrates a Cronbach's α coefficient of 0.93.

(3) Fertility Intention Scale (FIS). Developed by Taiwanese scholar Huang Sheng-Miao[22], the Fertility Intention Scale is a self-report instrument designed to assess fertility intentions among cancer patients of reproductive age.The scale comprises four dimensions: fertility risks, disease control, social support, and well-being, totalling 15 items. It employs a 5-point Likert scale, where scores of 1–5 represent "Strongly disagree," "Disagree," "Undecided," "Agree," and

"Strongly agree," respectively. Higher scores indicate stronger fertility intentions and greater desire for fertility health information. The scale's Cronbach's α coefficient is 0.87.

(4) Perceived Social Support Scale (PSSS). Developed by Blumenthal et al.[23] and translated into Chinese by Jiang Qianjin et al.[24], the PSSS comprises three dimensions: family support, friend support, and other support, with 12 items in total.The scale employs a 7-point Likert scale. The sum of individual item scores constitutes the total score, with total scores ranging from 12 to 28 indicating low levels of social support, 29 to 56 indicating moderate levels, and 57 to 84 indicating high levels. The scale's Cronbach's α coefficient was 0.971.

Data Collection and Quality Control Methods

The research team trained two investigators to ensure consistent application of the survey tools and standardized instructions. When conducting the survey, electronic questionnaires were distributed to discharged patients through Wenjuanxing, with each ID allowed to answer only once. For inpatients, paper questionnaires were distributed and collected on-site. All respondents filled out the questionnaires anonymously. Data were cross-checked by two investigators; any errors or omissions were promptly addressed through communication with respondents. Prior to questionnaire distribution, investigators provided detailed explanations of the study objectives and procedures, addressing respondents' queries.

Data analysis

Data analysis was performed using SPSS 27.0 software. Count data were described using frequency (n) and percentage (%).Continuous data meeting normal distribution requirements were described using mean ± standard deviation (Mean ± SD) and subjected to univariate analysis via t-tests and analysis of variance (ANOVA). Non-normally distributed continuous data were described using median and interquartile range [Median (P25, P75)] and analysed univariately using the *Mann-Whitney* U test.Pearson correlation analysis examined associations between fertility intentions, perceived social support, and fertility concerns. Multiple linear regression analysis was conducted with the RCAC-7 total score as the dependent variable and statistically significant variables from univariate ANOVA as independent variables. The significance level was set at α = 0.05.

Qualitative Research

Participants

Purposive sampling was employed to select interviewees from the 126 patients in the quantitative study. Adhering to the principle of maximum variation, multiple factors including age, occupation, and educational background were thoroughly considered. Sample size determination followed the principle of information saturation, with interviews concluding when no new themes emerged. Ultimately, 14 patients were interviewed: 8 females and 6 males. The age range was (34.43 ± 6.31) years. General characteristics of the interviewees are presented in Table 1(At the end of the article).

Table 1
General characteristics of participants (n = 14)

ID	Gender	Location	Marital Status	Educational Background	Nature of Employment	Average Monthly Household Income (¥)	Method of Medical Expense Payment	Tumour stage	Treatment method	Number of Children	Child's gender
N1	Male	Town	Unmarried	College	Unemployed	<5000	Self-funded	Stage II	Chemotherapy	0	-
N2	Female	Town	Secondary education or below	Married	Manual labour	<5000	Self-funded	Stage I	Surgical treatment	0	-
N3	Female	City (Town)	Undergraduate	Married	Intellectual work	5000-10,000	Employee Medical Insurance	Stage I	Chemotherapy	1	Male
N4	Male	Town	Undergraduate	Married	Intellectual work	5000-10,000	Resident Medical Insurance	Stage II	Radiotherapy	0	-
N5	Female	Town	Undergraduate	Single	Intellectual work	>10,000	Employee Medical Insurance	Stage III	Chemotherapy	0	-
N6	Female	Town	Undergraduate	Divorced	Intellectual work	5000-10,000	Self-funded	Stage III	Chemotherapy	0	-
N7	Female	Rural	Secondary School (Vocational College)	Married	Manual labour	<5000	Employee Medical Insurance	Stage II	Surgical treatment	2	Female
N8	Female	Town	College	Single	Intellectual work	5000-10,000	Resident Medical Insurance	Stage I	Surgical Treatment	0	-
N9	Female	Rural	Secondary School (Vocational College)	Married	Manual labour	<5000	Employee Medical Insurance	Stage III	Surgical treatment	0	-
N10	Female	Town	Secondary School (Technical College)	Married	Intellectual work	5000-10,000	Resident Medical Insurance	Stage IV	Chemotherapy	1	Male and Female
N11	Male	Town	Secondary education or below	Married	Unemployed	5000-10,000	Resident Medical Insurance	Stage IV	Chemotherapy	0	-
N12	Male	Rural	Secondary School (Vocational College)	Married	Intellectual labour	<5000	Employee Medical Insurance	Stage II	Other	2	Female
N13	Male	Town	College	Married	Intellectual work	5000-10,000	Employee Medical Insurance	Stage II	Surgical treatment	1	Male
N14	Male	Town	Postgraduate and above	Unmarried	Intellectual labour	>10,000	Resident Medical Insurance	Stage II	Surgical treatment	0	-

Interview Guidelines

This study, based on the four key factors of the ABC-X theoretical model, regards fertility issues as the stressor 'A' for middle-aged and young colorectal cancer patients. This interacts with their resources 'B' (including personal, family, and social resources) and their cognition 'C' regarding fertility events and disease, ultimately forming concerns and apprehensions 'X' about fertility issues—i.e., fertility anxiety.To precisely capture the core associations within the A, B, and C dimensions and the formation mechanism of the X dimension within the model, the interview outline was rigorously constructed according to the ABC-X theoretical framework.

Building upon prior literature review, the research team collaboratively designed the interview outline. Following preliminary interviews with two colorectal cancer patients meeting inclusion criteria, the final outline was finalised: How do you view fertility issues following your colorectal cancer diagnosis? From your personal perspective, what specific concerns regarding fertility currently exist? Have you discussed fertility matters with family members? What were their attitudes? How did this influence you?What societal factors do you believe could influence your reproductive decisions? How do you perceive your illness and treatment affecting your ability to have children? How do you view the pressures arising from reproductive concerns? How do you cope with the

stress related to reproductive issues? What professional channels or specific forms of support would you seek to assist you in making informed reproductive choices?

Data Collection and Quality Control Methods

Make an appointment with the patients in advance for the interview. Arrange the interviews for inpatients based on their free time, and conduct the interviews for discharged patients during their follow-up visits.Researchers adhered to principles of anonymity and strict confidentiality. Prior to interviews, patients were provided with detailed explanations regarding the purpose, content, and methodology of the interviews, thereby establishing trust and fostering positive nurse-patient relationships. During interviews, patients were encouraged to express their genuine feelings within a relaxed atmosphere.All interviews were audio-recorded throughout, with non-verbal cues such as gestures, facial expressions, and behaviours observed and documented. A total of 14 interviews were conducted over 866 minutes, with individual session durations ranging from 39 to 92 minutes (61.86 ± 17.94). Key interview content and information were promptly verified with participants.

Data Analysis

Following each interview, two researchers transcribed the recordings into text within 48 hours and imported the transcribed data into Nvivo 12.0 qualitative data analysis software.Data analysis employed Colaizzi's seven-step method[25], Multiple careful readings of interview transcripts - Extraction of key and meaningful statements - Coding of frequently occurring and significant viewpoints - Integration of coded content - Composition of detailed and comprehensive descriptions - Identification and synthesis of similar viewpoints to distil core themes - Final confirmation and validation through follow-up interviews with research subjects[26].

Results

Quantitative data

A total of 126 questionnaires were distributed, with 126 valid responses collected, yielding a 100% response rate. Females constituted 59.52% of participants.Analysis revealed that age, educational attainment, marital status, average monthly household income, number of children, gender of children, tumour stage, disease recurrence status, fertility intentions, and whether fertility information was actively sought all significantly influenced fertility-related anxiety scores among young and middle-aged colorectal cancer patients (all $P < 0.05$). Detailed findings are presented in Table 2.

Table 2
Comparison of Fertility Anxiety Scores Among Young and Middle-Aged Colorectal Cancer Patients with Different Characteristics (n = 126)

Item		Cases (%)	(Mean ± SD)	*t/F*	P-value
Gender	Male	51 (40.48)	24.65 ± 4.88	-0.504	0.615
	Female	75 (59.52)	25.07 ± 4.38		
Age (years)	18–35	52 (41.27)	23.92 ± 3.72	-2.028	0.045
	>35	74 (58.73)	25.58 ± 5.00		
Location	Town	116 (92.06)	24.97 ± 4.61	0.573	0.568
	Rural	10 (7.94)	24.10 ± 4.28		
Educational attainment	Junior secondary and below	20 (15.87)	26.90 ± 5.49	2.754	0.031
	Senior secondary (vocational secondary)	28 (22.22)	23.25 ± 4.47		
	College	38 (30.16)	24.37 ± 4.61		
	Bachelor's degree	26 (20.63)	26.23 ± 4.01		
	Postgraduate and above	14 (11.11)	24.29 ± 2.76		
Marital status	Unmarried	28 (22.22)	25.50 ± 2.52	3.797	0.012
	Married	91 (72.06)	25.02 ± 4.84		
	Divorced	6 (4.76)	19.33 ± 4.80		
	Widowed	1 (0.79)	30.00 ± 0.00		
Nature of work	Clerical work	76 (60.32)	24.80 ± 4.15	0.198	0.820
	Manual labour	33 (26.19)	25.30 ± 5.43		
	Unemployed	17 (13.49)	24.53 ± 4.81		
Average monthly household income (¥)	<5000	44 (34.92)	26.07 ± 4.38	3.131	0.047
	5000–10000	57 (45.24)	23.84 ± 4.74		
	>10000	25 (19.84)	25.24 ± 4.12		
Medical expense payment method	Resident Medical Insurance	42 (33.33)	24.05 ± 4.36	2.603	0.078
	Employee Medical Insurance	65 (51.59)	24.86 ± 4.70		
	Self-funded	19 (15.08)	26.89 ± 4.22		
Number of children (n)	0	52 (41.27)	25.83 ± 3.36	19.945	0.000
	1	44 (34.92)	26.52 ± 5.07		
	2	30 (23.81)	20.90 ± 3.20		
Male/Female Ratio	Male	24 (19.05)	25.25 ±	3.244	0.024

Item		Cases (%)	(Mean ± SD)	*t/F*	P-value
			4.67		
	Female	38 (30.16)	24.42 ± 5.77		
	Male & Female	11 (8.73)	21.36 ± 3.38		
	None	53 (42.06)	25.81 ± 3.32		
Tumour staging	Stage I	28 (22.22)	26.61 ± 4.22	2.782	0.044
	Stage II	72 (57.14)	24.25 ± 4.71		
	Stage III	16 (12.70)	26.00 ± 3.80		
	Stage IV	10 (7.94)	23.00 ± 4.40		
Treatment Approach	Surgical intervention	100 (79.37)	24.89 ± 4.64	0.012	0.998
	Radiotherapy	5 (3.97)	25.20 ± 2.49		
	Chemotherapy	15 (11.90)	24.93 ± 5.37		
	Other	6 (4.76)	24.67 ± 3.33		
Fertility intentions	Yes	91 (72.22)	26.71 ± 3.71	9.354	0.000
	No	35 (27.78)	20.17 ± 2.96		
Whether actively inquired about reproductive history	Yes	81 (64.29)	26.64 ± 3.98	6.670	0.000
	No	45 (35.71)	21.76 ± 3.87		
Has anyone proactively provided reproductive information?	Yes	24 (19.05)	24.29 ± 5.24	-0.719	0.474
	No	102 (80.95)	25.04 ± 4.42		
Awareness of reproductive technologies	Yes	27 (21.43)	24.78 ± 3.99	-0.152	0.879
	No	99 (78.57)	24.93 ± 4.74		
Recurrence	Yes	29 (23.02)	26.38 ± 4.52	2.013	0.046
	No	97 (76.98)	24.45 ± 4.52		
Family history	Yes	14 (11.11)	24.93 ± 4.41	0.027	0.978
	None	112 (88.89)	24.89 ± 4.61		

Among the 126 middle-aged and young colorectal cancer patients in this study, the mean fertility anxiety score was (24.9 ± 4.57), the mean fertility intention score was (40.29 ± 12.82), and the mean perceived social support score was (56.43 ± 9.95). The results of this study indicate that fertility anxiety among young and middle-aged colorectal cancer patients was positively correlated with fertility intention (r_s= 0.900, P< 0.01) and negatively correlated with perceived social support (r_s= -0.945, P< 0.01). Detailed findings are presented in Table 3.

Table 3
Pearson correlation analysis of fertility concerns, fertility intentions, and social support among young and middle-aged colorectal cancer patients (n = 126)

	Mean	SD	Fertility Anxiety	Fertility Intention	Social Support
Fertility concerns	24.90	4.57	1		
Intention to have children	40.29	12.82	.900**	1	
Social Support	56.43	9.95	-0.945**	-0.927**	1
Note: **. Significant at the 0.01 level (two-tailed).					

Using the fertility anxiety scores (raw values) of 126 middle-aged and young colorectal cancer patients as the dependent variable, the statistically significant independent variables identified in the univariate analysis were: Age, educational attainment, marital status, average monthly household income, number of children, gender of children, tumour stage, disease recurrence status, fertility desire, and whether fertility information was actively sought were included in the multiple linear regression analysis. The variable assignments and dummy variable settings are detailed in Table 4.Analysis revealed that fertility intentions and social support levels significantly influence fertility concerns among young and middle-aged colorectal cancer patients, explaining 93% of total variance (all $P < 0.05$). Fertility concerns were markedly higher among those aged > 35 compared to 18–35 years (β = 0.588).Those with secondary vocational education, college education, postgraduate education, and above exhibited significantly lower fertility anxiety levels than those with junior secondary education or below, β = -1.207, -1.075, -1.453; Stage IV tumours showed significantly lower fertility anxiety levels than Stage I, β = -1.167 (all $P < 0.05$). Details are presented in Table 5.

Table 4
Assignment of Independent Variables and Dummy Variable Configuration

Item	Independent Variable Assignment
Age (years)	18–35 = 0, > 35 = 1
Educational Attainment	Junior secondary school and below = 1 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 0, Z_5= 0)
	Secondary School (Vocational School) = 2 (Z_1= 0, Z_2= 1, Z_3= 0, Z_4= 0, Z_5= 0)
	College/Vocational College = 3 (Z_1= 0, Z_2= 0, Z_3= 2, Z_4= 0, Z_5= 0)
	Undergraduate = 4 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 1, Z_5= 0)
	Postgraduate and above = 5 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 0, Z_5= 1)
Marital Status	Unmarried = 1 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 0)
	Married = 2 (Z_1= 0, Z_2= 1, Z_3= 0, Z_4= 0)
	Divorced = 3 (Z_1= 0, Z_2= 0, Z_3= 1, Z_4= 0)
	Widowed = 4 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 1)
Average monthly household income (¥)	<5000 = 1 (Z1 = 0, Z2 = 0, Z3 = 0)
	5000–10000 = 2 (Z1 = 0, Z2 = 1, Z3 = 0)
	>10,000 = 3 (Z1 = 0, Z2 = 0, Z3 = 1)
Number of children	0 children = 1 (Z_1= 0, Z_2= 0, Z_3= 0)
	1 child = 2 (Z_1= 0, Z_2= 1, Z_3= 0)
	2 children = 3 (Z_1= 0, Z_2= 0, Z_3= 1)
Child gender	Male = 1 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 0)
	Female = 2 (Z_1= 0, Z_2= 1, Z_3= 0, Z_4= 0)
	Male and female = 3 (Z_1= 0, Z_2= 0, Z_3= 1, Z_4= 0)
	None = 4 (Z_1= 0, Z_2= 0, Z_3= 0, Z_4= 1)
Tumour staging	Stage I = 1 (Z1 = 0, Z2 = 0, Z3 = 0, Z4 = 0)
	Stage II = 2 (Z1 = 0, Z2 = 1, Z3 = 0, Z4 = 0)
	Stage III = 3 (Z1 = 0, Z2 = 0, Z3 = 1, Z4 = 0)
	Stage IV = 4 (Z1 = 0, Z2 = 0, Z3 = 0, Z4 = 1)
Desire to have children	Yes = 0, No = 1
Have you proactively inquired about fertility information?	Yes = 0, No = 1
Has the disease recurred?	Yes = 0, No = 1
Fertility intentions	Original value carried over
Social support	Original value carried forward

Table 5
Linear regression equation results for fertility concerns among young colorectal cancer patient (n = 126)

Variable		*B* value	Standard Error	*β*	*t*	*P*
(Constant)		42.436	3.450	-	12.300	0.000
Desired number of children		0.069	0.030	0.195	2.313	0.023
Social support		-0.348	0.041	-0.758	-8.51	0.000
Age (years)	Over 35 years	0.588	0.274	0.064	2.145	0.034
	18–35 years	0				
Educational attainment	Secondary school (vocational school)	-1.207	0.477	-0.110	-2.553	0.013
	College	-1.075	0.410	-0.108	-2.622	0.010
	Undergraduate	-0.792	0.424	-0.070	-1.866	0.065
	Postgraduate and above	-1.453	0.557	-0.100	-2.606	0.011
	Junior secondary education and below	0				
Marital status	Married	0.160	0.443	0.016	0.361	0.719
	Divorced	0.753	0.730	0.035	1.031	0.305
	Widowed	-0.815	1.520	-0.016	-0.537	0.593
	Unmarried	0				
Average Monthly Household Income (¥)	5000–10000	-0.062	0.299	-0.007	-0.207	0.837
	>10000	-0.077	0.384	-0.007	-0.201	0.841
	<5000	0				
Female	Female	0.296	0.375	0.030	0.790	0.431
	Male and Female	-0.026	0.586	-0.001	-0.045	0.964
	None	-0.505	1.023	-0.054	-0.494	0.623
	Male	0				
Number of children	One	0.320	1.013	0.034	0.316	0.753
	Two or more	0.444	1.105	0.041	0.402	0.689
	None	0				
Tumour staging	Stage II	-0.289	0.340	-0.031	-0.847	0.399
	Stage III	-0.240	0.447	-0.018	-0.537	0.592
	Stage IV	-1.167	0.552	-0.069	-2.114	0.037
	Phase I	0				
Fertility intentions	None	-0.251	0.668	-0.026	-0.375	0.708
	Yes	0				
Have you proactively inquired about fertility information?	No	0.008	0.454	0.001	0.017	0.986
	No	0				
Disease recurrence	Yes	0.248	0.307	0.023	0.808	0.421
	No					
a. Dependent variable: Fertility concerns						

Note

$R = 0.965$, $R^2 = 0.930$, *adjusted* $R^2 = 0.915$, F = 59.157.

Qualitative data

Causes of Fertility Anxiety

Fertility Concerns Exacerbate Stress Among Colorectal Cancer Patients

The diagnosis and treatment of colorectal cancer significantly impact patients' physical health, potentially affecting their reproductive function. This places considerable psychological pressure on patients when confronting fertility issues. Fertility remains an unavoidable concern for individuals within societal structures. Expectations from family and society compel patients to consider reproduction, thereby generating substantial pressure and burden.

(1) Some patients retain a desire for children but experience inner conflict due to disease limitations. N3: "Although I know chemotherapy may affect fertility, I really want my own child. If I cannot have children, I feel I would be letting my family down." N7: "I always feel that without children, my family would consider me incomplete. But is my physical condition even suitable now? Just thinking about it makes me feel distressed."

(2)Family members' expectations regarding childbearing intensify patients' stress. N2: "My husband has always wanted children, but doctors say pregnancy carries too high a risk for me now. I desperately want to fulfil his wish, yet fear it could harm my health – it leaves me torn." N9: "My parents used to speak constantly of wanting grandchildren. Though they don't mention it now that I'm ill, I know deep down they still yearn for a grandchild. But I'm uncertain whether my future health will permit childbirth."

(3) Societal and cultural factors also impose reproductive pressures. N5: "Relatives and classmates constantly discuss children. I have to change the subject, but I can't help wondering: what if I can't have children? Will people say my family isn't complete?" N9: "In my hometown, everyone believes a family isn't complete without children. I feel an immense weight on my shoulders. I dread facing this topic whenever I return home."

Limited Personal Resources to Address Fertility Concerns

When confronting fertility challenges, colorectal cancer patients require mobilisation of personal, familial, and societal resources. However, these resources are often insufficient or difficult to utilise effectively, thereby triggering fertility anxieties.

(1) Regarding personal resources, some patients adopt avoidance or passive coping strategies. N4: "I used to really want children, but now I hardly think about it at all and don't wish to learn any related information." N8: "Treatment and recovery have left me utterly exhausted. I simply can't bring myself to consider pregnancy and childbirth, nor dare I dwell on it too much ."

(2) Regarding family resources, some patients intensify fertility anxieties by withholding full disclosure of their condition or fearing lack of familial understanding and support. N1: "I haven't told my parents my fertility might be affected after chemotherapy. They keep pressuring me to have children. I feel they don't understand me, and the pressure is immense." N10: "I'm uncertain whether they could accept the special care I'd need if I became pregnant. This makes me very hesitant."

(3) Regarding social resources, despite the medical team providing fertility-related counselling and support programmes, patients still feel pressured. N6: "The doctor seriously explained all the possibilities to me, but I'm still afraid my body won't cope. I feel uneasy." N11: "Although the hospital has assisted reproductive policies, the costs and process make me feel under immense pressure."

Misconceptions Regarding Fertility Issues

Some colorectal cancer patients harbour misconceptions about the relationship between their illness and fertility, leading to pessimistic responses to reproductive concerns that hinder resource mobilisation. N3: "I feel pregnancy after cancer treatment must be dangerous, and the child could have problems. I fear I couldn't bear that." N7: "I now feel I might never be suited to having children. Every time I think about it, I feel anxious."" N5: "Although I desire children, I constantly feel unworthy of parenthood and fear I would be a poor parent."

Manifestations of Fertility Anxiety

Concerns Regarding Personal Health

Colorectal cancer and its treatments can severely impact physical health and reproductive function, leading some patients to worry about their health when considering conception. N2: "I fear pregnancy might hinder my recovery and increase the risk of cancer recurrence. My heart races whenever I think about it." N5: "The doctor said chemotherapy could affect ovarian function. I'm unsure if I'll ever be able to have children. The thought of losing that chance makes me deeply sad."" N8: "I fear pregnancy could hinder my physical recovery or even compromise my future quality of life. This anxiety has been a constant companion."

Concerns Regarding Personal Fertility

Colorectal cancer and its treatments may impact patients' reproductive function. Some worry about their future ability to conceive or carry a pregnancy to term, leading to fertility anxieties. N3: "The doctor said chemotherapy could damage my ovarian function. I constantly fear I might never be able to have children, which fills me with dread and despair." N7: "At every follow-up appointment, I think about how if my health deteriorates, having a child might be delayed indefinitely or even impossible. I truly don't know what to do."" N5: "Whenever I contemplate potentially losing my fertility, it feels like a piece of my life is missing. It's deeply distressing, and I even cry." N9: "I fear my body might not withstand pregnancy, and worry the child's health could be affected. Thinking about these issues makes my heart race, like a heavy stone pressing on my chest."

Concerns regarding pre-pregnancy/pregnancy interventions

Some patients require additional measures or adjustments to their treatment plan before or during pregnancy to safeguard their own health and that of the foetus, but limited understanding of this can cause concern.N3: "I worry whether IVF might be harmful to my health, and I'm unsure if my husband supports

these complex procedures." N9: "The doctor advised delaying pregnancy. I actually want a child, but I feel conflicted because there are so many concerns. My husband reassures me, yet I constantly feel I'm holding back everyone's happiness." N6: "The fertility process may involve injections and medication. I fear my body might not cope, yet I still want to try. It's a deeply conflicting feeling."

Concerns Regarding Intimate Relationships

Some patients fear colorectal cancer and its treatment may negatively impact their partner relationship, sexual intimacy, and marriage, amplifying fertility anxieties. N6: "I worry my physical condition after chemotherapy might affect intimacy with my husband. Could he grow distant because of it?" N1: "I dread being unable to satisfy my partner's needs and fear it might strain our bond." N5: "Sometimes I wonder if failed pregnancy attempts or fertility limitations might cause conflicts between us, or even threaten our marriage stability." N4: "I fear my condition and treatment might exhaust or disappoint her, causing her to gradually withdraw from me. That thought is particularly heartbreaking." N8: "Whenever we discuss having children, I worry it might overwhelm him. I dread the possibility of arguments or our relationship being damaged. I dare not think about it."

Concerns about parenting capacity

Patients worry their physical and financial resources may be insufficient to support a child's upbringing, particularly during illness treatment and recovery phases. N4: "I fear my body won't hold up, leaving me unable to care for the child when needed." N7: "Treatment and follow-up appointments are costly. How will we manage the child's living expenses and education? Sometimes I feel utterly helpless." N2: "If my health deteriorates later, how long could I still care for the child? I constantly worry I won't be able to cope."

Impact of Fertility Concerns

Exacerbating Negative Emotions

Colorectal cancer patients already bear psychological burdens from their illness; fertility concerns further intensify negative emotions. N5: "Whenever I think I might not be able to have children, I feel anxious, helpless, and sometimes even lose sleep." N2: "I was already afraid of recurrence, and now I have to consider pregnancy too. The pressure is immense, and I easily become depressed."" N8: "I want children, but I worry about my health. It's like having a stone pressing on my chest every day. My mood is absolutely dreadful."

Disrupting Family Harmony

Fertility concerns may lead to conflicts with partners and family members over reproductive decisions, thereby affecting family relationships. N3: "My husband keeps pressuring me, but I worry about my physical condition. Every time we discuss having children, we end up arguing, and the atmosphere becomes very tense." N9: "My parents have always wanted grandchildren. I can't guarantee safety or health, so I've had to explain repeatedly, but they just don't understand."" N6: "Whenever we discuss our family planning, my partner and I become emotionally charged, even blaming each other. This causes me immense distress."

Disrupting Patients' Treatment and Fertility-Related Decisions

Fertility anxieties not only impact patients' emotional experiences and family dynamics but also permeate critical decision-making processes concerning disease treatment and reproductive planning.

(1)When confronting choices regarding treatment protocols, timing of conception, and fertility preservation measures, patients frequently become entangled in repeated deliberations due to uncertain perceptions of their own health status and potential risks to offspring. This manifests as pronounced hesitation, avoidance, or even decision-delaying tendencies. N5: "The doctor said chemotherapy should start promptly, but I kept worrying whether treatment might render me permanently infertile. I felt utterly conflicted and couldn't bring myself to decide."N8: "On one hand, I want to treat the illness first; on the other, I fear missing the optimal window for having children. No matter which option I choose, it feels wrong. I feel utterly lost."(2) Some patients even hesitate about standard treatment due to fertility concerns, or make passive choices without sufficient information, further exacerbating their psychological burden. N10: "Sometimes I think, perhaps I shouldn't pursue such aggressive treatment now to preserve future possibilities, yet I know this isn't rational—I'm deeply conflicted."

Discussion

This study reveals that fertility anxiety scores among young and middle-aged colorectal cancer patients (24.9 ± 34.58) fall within the moderate-to-high range. Linear regression analysis indicates that fertility intention and social support are independent factors influencing fertility anxiety. Higher fertility intentions correlate with heightened anxiety, while lower social support levels also increase anxiety.Interpreted through Lazarus's cognitive appraisal theory of stress[27], primary and secondary appraisals constitute two relatively independent cognitive stages. Thus, both factors independently contribute to the final anxiety level. Even patients with extremely high fertility intentions may exhibit lower anxiety levels than those with high intentions and low support if social support is sufficient. Concurrently, research confirms no interaction between these factors, indicating no significant interaction effect between fertility intentions and social support on fertility anxiety. For instance, Benedict C et al.[28] demonstrated that both variables retained independent significance when simultaneously included in regression models, with no significant interaction effect. This suggests social support can mitigate but not eliminate the anxiety stemming from high fertility intentions. Thus, while social support cannot eradicate such anxiety, it can reduce its absolute level.

Young and middle-aged patients are at the peak of their personal life course for fertility desires while bearing intense expectations from family and society. The diagnosis and treatment of colorectal cancer, particularly the potential or certain damage to reproductive function from radiotherapy and chemotherapy,

constitute the most fundamental physiological and existential stressors.This qualitative study further reveals that fertility aspirations among patients do not stem solely from personal reproductive intent, but rather represent the internalisation of multiple pressures: elders' expectations for bloodline continuity, the traditional societal belief that "a complete family requires children," and social comparison pressures arising from peers' reproductive behaviours[29].These factors amplify patients' reproductive pressures. On one hand, they view childbearing as central to achieving life's completeness and fulfilling familial responsibilities; on the other, they remain acutely aware that disease and treatment may compromise fertility. This serves as a reminder that fertility preservation should be proactively included in pre-treatment discussions, helping patients transition from passive recipients of pressure to informed decision-makers.

The findings of this study indicate that only 19.05% of patients had received proactive fertility information from others, and patients with lower household incomes exhibited significantly higher fertility anxiety scores ($P < 0.05$). Qualitative analysis revealed that some patients lacked understanding of fertility information and technologies, while the time toxicity of the disease—particularly the heightened financial burden—exacerbated their fertility concerns.Peng C et al.[30] found that among patients with early-onset colorectal cancer, only approximately 15–44% received fertility counselling prior to treatment, with lower counselling rates observed in those aged > 40 years, male patients, and low-income groups. These findings align with the present study. An inadequate social support system represents another resource constraint for young and middle-aged colorectal cancer patients, a problem particularly pronounced among low- and middle-income groups.A Guangzhou-based study revealed significantly higher fertility anxiety scores among low-income patients compared to high-income counterparts, confirming economic status as an independent factor influencing fertility concerns.The study further highlighted that China's current medical insurance policies regarding fertility preservation and assisted reproductive technologies for cancer patients remain inadequate. Only a few regions include sperm cryopreservation within their insurance reimbursement scope, while the out-of-pocket costs for egg and embryo cryopreservation range from 30,000 to 80,000 yuan. This far exceeds the affordability threshold for low-income patients, leading many with fertility aspirations to abandon their plans due to financial constraints, thereby exacerbating their anxiety[31].Thus, the mixed-methods findings of this study indirectly suggest that household income fundamentally reflects disparities in resource accessibility. This underscores the need to enhance attention to fertility issues and improve the quality of fertility counselling.

The findings reveal that patients with lower educational attainment exhibit the highest fertility anxiety scores, a statistically significant difference ($P < 0.05$).This phenomenon transcends mere "knowledge alleviating anxiety," revealing cognitive flexibility as a crucial psychological protective mechanism. Higher-educated individuals typically possess stronger information-seeking and critical evaluation abilities, partially reframing reproduction from an "obligatory social duty" to "one of life's optional experiences." This shift mitigates fertility-related anxieties arising from diminished reproductive prospects. Some patients harbour excessively pessimistic or one-sided perceptions regarding the relationship between disease and fertility.Research indicates that cancer patients under disease-related stress are more prone to catastrophic thinking, holding either extremely pessimistic or unrealistic expectations regarding fertility outcomes. Such misconceptions may stem from self-sourced online information, social media discussions, or even non-professional advice. This information often lacks accuracy or contextual relevance, readily leading to increased anxiety through erroneous beliefs[32]. This underscores the importance of promptly providing relevant fertility information to patients with lower educational attainment to alleviate their fertility concerns.

Linear regression results from this study indicate significantly heightened fertility anxiety among patients over 35 years of age. This age threshold coincides with the physiological inflection point of female fertility. For patients aged 35 and above, particularly women, the biological window for conception has markedly narrowed[33]. The threat of fertility impairment from cancer treatment triggers fears of losing their "last chance to conceive".Qualitative research reveals that patients in this age group commonly face the dual societal demands of "family formation" and "career development." A cancer diagnosis abruptly interrupts this trajectory, inducing intense feelings of "stalled development" and "deprivation of future prospects." In contrast, younger patients, though similarly threatened, possess relatively longer anticipated reproductive windows. Consequently, their fertility concerns may be partially mitigated by the hope that "there is still time ahead"[34].

A counterintuitive finding in this study is the non-linear relationship between disease stage and fertility concerns, with stage IV patients scoring lower on fertility anxiety than stage I patients.Qualitative interview findings offer a key explanation: Stage IV patients prioritise survival, focusing primarily on disease treatment and longevity, with fertility planning deferred. Stage I patients, however, experience a conflicted state. While enjoying favourable survival prognosis, they must confront the threat treatment poses to reproductive function. This duality constitutes a significant source of their anxiety. This finding alerts clinicians that early-stage patients with good prognosis represent precisely the group most in need of, yet most easily overlooked, psychological interventions regarding fertility.

This study reveals that fertility concerns influence patient decision-making, potentially leading to treatment choices detrimental to cancer prognosis. Interview findings indicate that patients with strong fertility intentions prioritise fertility preservation in treatment decisions, favouring therapies with minimal reproductive system damage. This significantly disrupts treatment adherence.A cohort study of breast cancer patients revealed that 65% of those reporting "very concerned" about fertility issues stated this anxiety "greatly" influenced their treatment decisions. The most common behavioural change was shortening the planned duration of endocrine therapy (68%), with some patients even abandoning endocrine therapy or chemotherapy altogether[35].A Singaporean study similarly confirmed that 46.1% of women of reproductive age with cancer felt fertility concerns influenced their treatment decisions in some way[36]. In summary, clinical practice requires identifying patients with high anxiety levels. Through timely, comprehensive information support and psychological intervention, we must prevent them from making irrational treatment compromises due to excessive worry, while respecting the decision autonomy of patients with differing priorities.

Conclusion

Despite employing a mixed-methods approach, this study retains limitations. Quantitative samples may have excluded patients who declined participation due to excessive anxiety, potentially underestimating concern levels. Male participants' avoidance of fertility topics in qualitative interviews may have hindered comprehensive understanding of gender differences.Future research may employ longitudinal designs to track the dynamic evolution of fertility concerns across treatment stages, or conduct couple-matched studies to elucidate relational interaction mechanisms. Crucially, culturally specific fertility concern assessment tools require development, integrating the China-specific sociocultural dimensions revealed herein (eg. pressure regarding offspring gender, familial expectations) into standardized measurement.

In summary, fertility concerns among middle-aged and young colorectal cancer patients stem from combined individual, familial, and societal influences. Clinical interventions confined solely to fertility preservation techniques are unlikely to fundamentally address the deeper sources of patients' anxieties. A multidisciplinary approach integrating medical, nursing, psychological, and social work services is required to establish a tripartite medical-psychological-social support system. Only through such collaborative efforts can fertility anxieties be effectively alleviated, thereby enabling patients to achieve a higher quality of survival.

Abbreviations

Full form	Abbreviation
Reproductive Concerns After Cancer Scale-7	RCAC-7
Perceived Social Support Scale	PSSS
Fertility Intention Scale	FIS
analysis of variance	ANOVA

Declarations

Ethical approval vs. participation informed consent

This study has been approved by the Medical Ethics Committee of Central Hospital, Tianjin University /Tianjin Third Central Hospital (approval number: IRB2025-091-01). All participants were fully aware of the purpose, process, potential risks and benefits of this study, and voluntarily signed a written informed consent form. This study is carried out in strict accordance with ethical norms to effectively protect the privacy and rights of participants throughout the research process.

Issued consent

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during this study are not publicly available due to the need to protect participant privacy, but are available from the corresponding authors upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest.

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