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Research

Explore Potential Profiles and Influencing Factors for Financial Toxicity in Patients with Colorectal Cancer Undergoing Chemotherapy: A Cross-Sectional Study

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ABSTRACT

Objectives: To explore the potential financial toxicity (FT) profiles in patients with colorectal cancer (CRC) undergoing chemotherapy and analyze its influencing factors.
Methods: A cross-sectional study was conducted on 373 CRC patients undergoing chemotherapy in southwest China from January 2024 to May 2024. We utilized the General Information Questionnaire, the FT based on Patient-Reported Outcome Measures (COST-PROM), the Brief Illness Perception Questionnaire (BIPQ), and the Family APGAR Index (APGAR). Latent profile analysis (LPA) by Mplus8.3 was used to identify the latent profiles of the FT. Multinomial logistic regression analysis was used to analyze the relevant factors in the different categories.
Results: The patients with CRC undergoing chemotherapy were divided into four profiles: high FT group (44.5%), moderate FT-low psychological adaptation group (22.8%), moderate FT-high psychological adaptation group (18.0%), and low FT group (14.7%). Age, average monthly household income per capita, employment status, disease duration, round of chemotherapy, illness perception, and family function were the influencing factors for potential profiles of FT in CRC chemotherapy patients ($P < 0.05$).
Conclusions: There are four potential profiles of FT in patients with CRC undergoing chemotherapy. Healthcare providers should pay attention to patients with CRC undergoing chemotherapy aged 18 to 59 years old, employed and unemployed, with lower average monthly household income per capita, disease duration of less than 1 year, and more times of chemotherapy. Additionally, reducing patients' negative perceptions of the disease and improving family function can help lower the level of FT.
Implication for Nursing Practice: This research can assist nurses in identifying patients at high risk of FT, enabling early intervention and the implementation of targeted psychological nursing interventions. Nurses can help patients develop positive perceptions of the disease and improve family relationships, thereby mitigating the negative effects of FT.

Introduction

Colorectal cancer (CRC) is among the most prevalent cancers affecting the digestive system.[1] Globally, there are approximately 1.93 million new cases and 900,000 deaths from CRC each year, making it the third most frequent cancer and the second leading cause of cancer-related deaths.[2] As treatment technologies advance and patient survival times increase, the cost of treatment has risen significantly.[3,4] In China, the annual treatment cost for CRC patients amounts to 13.461 billion yuan.[5] Therefore, CRC not only leads to high mortality rates but also imposes a substantial economic burden on governments and societies.

For cancers with a high propensity for dissemination, where local treatments such as surgery and radiotherapy alone are insufficient to prevent recurrence and metastasis, chemotherapy of varying degrees is often required.[6] Chemotherapy has become one of the most widely used and effective treatments for CRC patients. A systematic review

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Layperson Summary

What we investigated and why

Colorectal cancer (CRC) is one of the most common malignant tumors, and patients suffer from severe financial toxicity (FT) during long-term chemotherapy. This study investigated the the potential profiles of FT in patients with CRC undergoing chemotherapy and analyzed its influencing factors.

How we did our research

We conducted a survey involving 373 CRC patients undergoing chemotherapy in the oncology department. The survey covered various aspects such as financial toxicity, illness perception, and family function. This data was collected through between January and May 2024.

What we have found

The patients with CRC undergoing chemotherapy were divided into four profiles. Age, average monthly household income per capita, employment status, disease duration, number of chemotherapy, illness perception and family function were the influencing factors for potential profiles of FT.

What it means

The findings reveal key factors that influence potential categories of FT, and nurses can use this information to develop personalized care plans. Meanwhile, the level of FT was reduced by reducing patients' negative illness perception and improving family functioning.

by Bhimani indicated that the direct medical costs for managing CRC range from $2,045 to $10,772 per year, while the indirect medical costs range from $551 to $795 per year.[7] Chemotherapy, as a component of direct medical costs, may be the biggest driver of the economic burden for patients with CRC.[8] Previous studies have found that patients undergoing chemotherapy are more likely to report high financial toxicity compared to surgery, surgery combined with radiotherapy, and hormone therapy alone.[9] The main medical expenses for patients undergoing chemotherapy are drugs, which account for the highest proportion of all hospital expenses for CRC patients.[10] As for the high proportion of drug costs, on the one hand, because the anticancer drugs with better effects are mostly dependent on imports, the price is high due to high tariffs, few suppliers, and other factors; On the other hand, the high cost and long cycle of drug research and development are not conducive to reducing the price of anticancer drugs.[11] Therefore, patients undergoing chemotherapy suffer a more severe financial burden. In addition, chemotherapy can adversely affect normal tissues and systems, causing symptoms such as vomiting, diarrhea, bone marrow suppression, and liver damage.[12] These severe side effects often necessitate additional medication interventions, which can extend hospital stays and further increase hospitalization costs.[13] Chemotherapy imposes a substantial economic burden on patients with CRC and the healthcare system.[14]

Financial Toxicity (FT) was introduced by American scholar Zafar in 2013,[15] referring to the adverse effects on patients and their families caused by the high costs of cancer treatment, including both objective financial burden and subjective financial distress. The objective financial burden refers to the objective economic problems such as treatment expenses, living costs, and time costs; the subjective financial distress refers to the negative emotions related to patients' subjective feelings such as psychological pressure and pain caused by economic pressure.[16] A survey revealed that the incidence of FT among patients with cancer is 82.6%.[17] China has successfully achieved near-universal health insurance coverage by establishing a mixed insurance system. This system comprises Urban Employees Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI), the New Rural Cooperative Medical Scheme (NCMS), and supplementary Catastrophic Health Insurance.[18] Despite the Chinese government's continuous expansion of medical insurance reimbursement for anti-cancer drugs, patients in China still face relatively weak financial risk protection due to socioeconomic, cultural, and political factors.[19] As a result, many patients must bear high out-of-pocket expenses and may fall into financial difficulties because of the high cost of treatment. The FT research in China remains in a developmental stage, primarily focusing on chronic diseases such as breast cancer, chronic kidney disease, hepatitis B, and other chronic illnesses, studies on FT in CRC patients receiving chemotherapy are still lacking.[20] A cross-sectional study by He indicated that FT may further influence subsequent treatment decisions.[21] Furthermore, FT not only alters patients' lifestyles but also leads to poor health outcomes, thereby affecting their quality of life.[22,23] Therefore, it is necessary to further understand the current status and influencing factors of FT in CRC patients undergoing chemotherapy.

A growing number of studies have shown that psychological factors play a crucial role in the FT.[15,24] Illness perception refers to the cognitive evaluation that patients form regarding their illness, which includes understanding its symptoms and progression based on their experiences.[25] Dong's study found a significant positive correlation between FT and negative psychological factors in patients undergoing chemotherapy.[26] A systematic review pointed out that patients' negative emotions can aggravate FT; for example, patients with negative illness perception have a more severe perception of FT.[27] Additionally, Perni found a correlation between illness perception and FT in patients with cancer, indicating that more negative illness perceptions are associated with higher FT levels.[28] However, there is limited research exploring the relationship between illness perception and FT in patients with CRC undergoing chemotherapy. Therefore, this study aimed to determine whether illness perception influences the level of FT in these patients.

Family functioning may significantly affect the experiences of FT among patients with cancer.[29] Family functioning refers to the extent of help and care provided by family members to an individual (e.g., a parent) and is primarily used to assess the satisfaction of family members with the overall family dynamics.[30] A multicenter cross-sectional study by Chen et al.[31] on young and middle-aged breast cancer patients indicated that better family cohesion is associated with more support from family members and less FT experienced by patients. Similarly, a study by Shao et al.[32] identified a correlation between family cohesion and FT in postoperative CRC patients. Therefore, strong family functioning may help patients and their families to better manage financial difficulties, thereby reducing the impact of FT on patients' quality of life and treatment outcomes. However, there is limited research on the relationship between family function and FT in patients with CRC undergoing chemotherapy.

While current studies have investigated the FT experienced by patients with CRC, most have employed variable-centered research approaches. These studies often neglect the heterogeneity within the CRC chemotherapy population by failing to explore the combinations of subgroups. Latent Profile Analysis (LPA) is a person-centered research method that categorizes observation units into multiple latent classes, which allows for the exploration of subgroup characteristics and their relationships with other variables.[33] This study uses LPA to identify latent profiles of FT among patients with CRC receiving chemotherapy. Its objectives are to determine the factors influencing these profiles and assess whether different types of FT are associated with illness perception and family function. Furthermore, the findings may provide clinical healthcare providers with

valuable insights into the FT experienced by these patients, thereby guiding the development of scientifically sound and feasible individualized interventions.

Methods

Study Design and Participants

This cross-sectional study employed convenience sampling to select patients with CRC undergoing chemotherapy who visited the oncology departments of three tertiary hospitals in Chengdu, Sichuan Province, China, between January 2024 and May 2024. The inclusion criteria for this study were as follows: (1) age of 18 years or older; (2) a clinicopathological diagnosis of CRC, with hospitalization for chemotherapy; (3) were able to communicate in Mandarin (Mandarin is the primary language of communication in China); (4) awareness of their disease condition and medical treatment; (5) informed consent and voluntary participation. The exclusion criteria included patients with a history of mental illness or hearing disorders, as well as those receiving chemotherapy in an outpatient setting.

This study primarily involved LPA and multinomial logistic regression analysis. For LPA, Nylund-Gibson and Choi have suggested that the minimum adequate sample size criterion for the LPA should be 300 cases.[34] For multinomial logistic regression analysis, the sample size is typically calculated as 10 to 15 times the number of independent variables.[35] With 25 independent variables, the required sample size ranges from 250 to 375 cases. Considering a 10% sample attrition rate, the final sample size should be between 275 and 412 cases. In total, this study included 373 patients.

Procedure

In this study, the researcher and team members acted as the principal investigators and data collectors. Initially, patients were recruited by posting flyers in the inpatient oncology wards. These flyers introduced the research background, objectives, inclusion criteria, and contact details. With the assistance of clinical nurses, the researchers also checked the department's electronic medical record system daily to promptly screen patients who met the inclusion criteria. After obtaining basic details about the patients, the researchers communicated with them to enquire about their willingness to participate in the study. Upon obtaining informed consent, the researchers distributed the questionnaires to the patients. In principle, all questionnaires were completed by the participants themselves; however, for patients with visual impairments or reading difficulties, investigators assisted by reading each item aloud using neutral and non-suggestive language. Notably, a total of 14 participants experienced difficulties reading the questionnaire items due to impaired vision in this study. However, with the assistance of the researchers, they were still able to complete the questionnaires. Upon completion, investigators collected the questionnaires on the spot, checked them for completeness, and reconfirmed with participants if any items were missing. With the assistance of clinical nurses, they also reviewed medical records to obtain necessary details on socio-demographic and disease characteristics. On average, participants took approximately 15 to 20 minutes to complete the questionnaire.

This study employed convenience sampling and conducted surveys in the oncology wards of three tertiary hospitals in Chengdu. Initially, 400 patients with CRC undergoing chemotherapy were approached. Of these, 7 patients declined participation because their carers did not consent, and 20 patients discontinued the questionnaire due to physical discomfort during completion. As a result, a total of 373 valid questionnaires were collected, yielding an effective response rate of 93.3%. The data collection flowchart is provided in Fig. 1.

Research Instruments

Socio-Demographic and Disease Characterization Questionnaire

The socio-demographic data of the patients include age, gender, marital status, educational level, average monthly household income per capita, employment status, residence, number of children, and methods of payment for medical expenses. The disease-related data encompass the tumor stage, history of surgery, history of stoma, chronic comorbidities, disease duration, and round of chemotherapy.

Financial Toxicity

The FT levels of patients with CRC undergoing chemotherapy were assessed using the Comprehensive Scores for FT Based on the Patient-reported Outcome Measures (COST-PROM). The COST-PROM covers both subjective and objective assessments of patients, offering a balanced content with fewer items, making it convenient to use and highly practical. It has been widely applied across various countries and populations.[36] This instrument has been testing the Chinese version by Yu, demonstrating the content validity index of 0.82 and Cronbach's α coefficient of 0.889.[37] The COST-PROM consists of 11

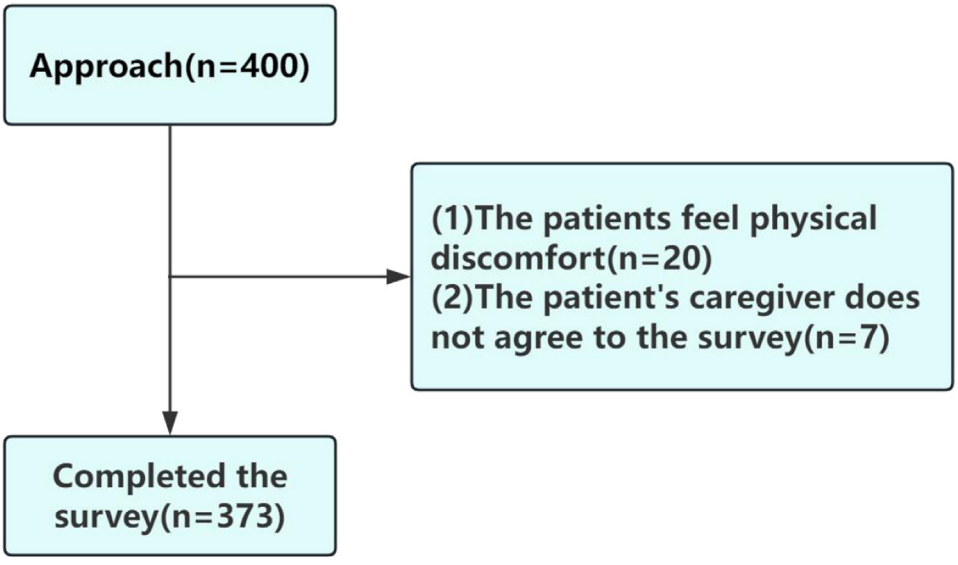

Fig 1. A flow chart about data collection.

items, covering two dimensions: positive financial status and negative psychological responses. It employs a 5-point Likert scale, ranging from 0 (not at all) to 4 (very much), with a total score range of 0 to 44. It is worth noting that lower scores indicate more severe FT. In this study, the Cronbach' s α coefficient for the scale was 0.931.

Illness Perception

This study utilized the Brief Illness Perception Questionnaire (BIPQ) to assess patients' illness perception levels. This instrument has been testing the Chinese version by Mei, demonstrating the content validity index of 0.81 and Cronbach's α coefficient of 0.77.[38] The BIPQ comprises nine items, covering three dimensions: illness understanding, illness cognition, and emotional response. The BIPQ uses a 0 to 10 scale, with a total score of 80. Higher scores indicate that the respondents perceive the illness as more threatening and have a more negative perception of the illness. In this study, the Cronbach's α coefficient was 0.808.

Family Function

This study used the Family APGAR Index (APGAR) to assess patients' subjective satisfaction with family function. This instrument has been testing the Chinese version by Lv, demonstrating the content validity index of 0.83 and Cronbach's α coefficient of 0.80.[39] The APGAR includes five dimensions: family adaptation, partnership, growth, affection, and intimacy. The total score ranges from 0 to 10, with higher scores indicating better family function. In this study, the Cronbach's α coefficient was 0.878.

Data Analysis

Data were analyzed using SPSS version 26 (IBM Corp, Armonk, NY) and Mplus version 8.3. Continuous variables with a normal distribution were described using Mean ± Standard Deviation, while categorical variables were described using frequency and composition ratio.

LPA was utilized to explore the optimal number of FT profiles among patients with CRC undergoing chemotherapy. The analysis began with a single-class model and incrementally increased the number of classes until the model fit indices reached their optimal levels. Model fit indices included: (1) the log-likelihood ratio, Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC (aBIC). Lower AIC, BIC, and aBIC values indicate better model fit; (2) Entropy, ranging from 0 to 1, with values closer to 1 indicating more precise classification. Entropy values below 0.6 suggest over 20% misclassification, while values above 0.8 indicate 90% classification accuracy;[40] (3) the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR) and the Bootstrap likelihood ratio test (BLRT). A *P*-value less than .05 indicates that the k-th model is superior to the (k-1)-th model.[41]

The characteristics of different FT categories among CRC chemotherapy patients were compared using one-way ANOVA, χ^2 tests, or Fisher's exact test. Additionally, unordered multinomial logistic regression analysis was employed to explore the various influencing factors of FT latent classes in these patients. A P-value less than 0.05 was considered statistically significant.

Ethical Considerations

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the Chengdu Medical College. The ethical approval number of the study is [2024No. 08]. The researchers explained the study to eligible participants. Each participant signed a written informed consent form before participating.

Results

Characteristics of Participants

Male patients accounted for 67.8 % and female patients accounted for 32.1%. The average age of patients was 59.57 ± 9.86 years, 51.2 % of the patients were 18 to 59 years old. Nearly all patients were married (92.8%). A total of 36.2 % of the patients had an educational level of junior high school, followed by primary school or below (33.0%). Nearly half of the patients had a monthly household income of less than $412 (44.5%). Most patients were not working (45.0%), and urban residents accounted for 54.2% of the patients, while 45.8% lived in towns or rural areas. Most patients had one child (55.2%). Among the patients surveyed in this study, 49.3% were in clinical stage IV, 88.5% had no history of a stoma and 51.5% had a surgical history. Additionally, 61.1% of the patients had no chronic comorbidities. Most patients had a disease duration of fewer than six months (44.0%), and underwent 1 to 4 chemotherapy sessions accounting for 51.5%. Regarding the payment methods for medical expenses, 42.1 % of the patients were covered by UEBMI, followed by NCMS (38.1%). (Supplementary Material 1).

Latent Profile Analysis Results

Establishment of the Latent Profile Model for Patients' FT

Using the 11 items of FT as manifest indicators, we incrementally fitted latent profile models from a baseline model with one class to models with up to five classes (Table 1). As the number of classes increased, AIC, BIC, and aBIC values gradually decreased. The LMR and BLRT showed statistical significance ($P < .05$) for models with 2, 3, and 4 profiles. The model with four profiles had the highest Entropy value of 0.947. Although the LMR remained significant when the number of classes increased to five, the Entropy value decreased. Therefore, the four-class model demonstrated the best fit. Based on model fit indices and clinical interpretability, we selected the four-class model as the optimal fitting model.

Naming of Each Latent Profile

Fig. 2 illustrates the latent profiles of the four categories across the 11 manifest indicators (Fig. 2). In this study, the probabilities of occurrence for Profile 1, Profile 2, Profile 3, and Profile 4 within the

Table 1
Fit Indices for the Five Models Using LPA ($N = 373$)

Profile	AIC	BIC	aBIC	Entropy	LMR(*P*-value)	BLRT(*P*-value)	Profile prevalence
1	14,085.923	14,172.198	14,102.399	-	-	-	1.00
2	12,157.337	12,290.671	12,182.799	0.938	<0.001***	<0.001***	0.58/0.42
3	11,526.909	11,707.301	11,561.357	0.944	<0.001***	<0.001***	0.45/0.37/0.18
4	11,161.329	11,388.781	11,204.764	0.947	0.0059**	<0.001***	0.45/0.23/0.18/0.14
5	11,019.908	11,294.419	11,072.329	0.935	0.0078**	<0.001***	0.38/0.14/0.17/0.17/0.14

** $P < .01$.
*** $P < 0.001$;
AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, adjusted Bayesian information criterion; BLRT, bootstrap likelihood ratio test; LMR, Lo–Mendell–Rubin likelihood ratio test.

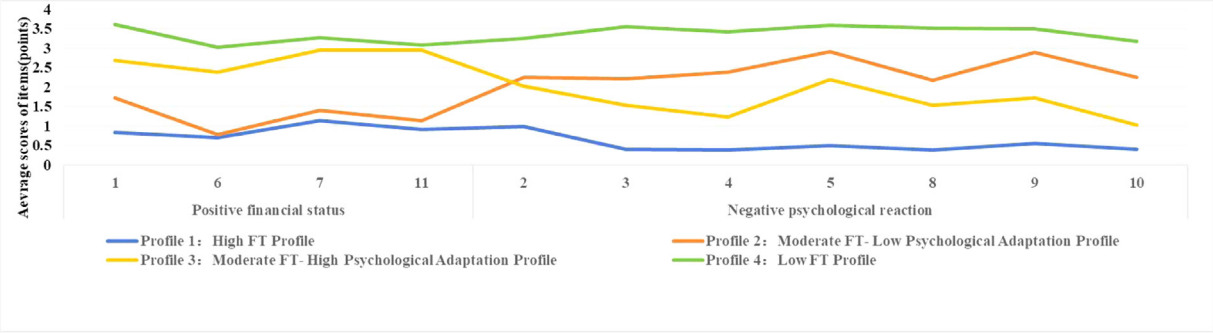

Fig 2. Latent profiles of the FT among patients with CRC undergoing chemotherapy.

total sample were 44.5% (n = 166), 22.8% (n = 85), 18.0% (n = 67), and 14.7% (n = 55), respectively. The mean scores of COST-PROM for patients in Profile 1, Profile 2, Profile 3, and Profile 4 were 7.23 ± 0.32, 22.19±0.47, 22.48 ± 0.51, and 37.16 ± 0.50, respectively. It is noteworthy that according to the FT-PROM definition scale, higher FT scores indicate lower levels of FT. The Profile 2 group had a higher average score in the negative psychological response dimension (17.14 ± 0.38), whereas the Profile 3 group had a lower average score in the same dimension (11.40 ± 0.43). Therefore, Profile 1, Profile 2, Profile 3, and Profile 4 were classified as the high FT group, moderate FT-low psychological adaptation group, moderate FT-high psychological adaptation group, and low FT group, respectively.

Predictors of the Latent Profile Membership

A univariate analysis was conducted using the four categories of FT among CRC chemotherapy patients as the dependent variable. Sociodemographic and disease characteristics, BIPQ scores, and APGAR scores were used as independent variables. The results of the univariate analysis indicated that differences in age group ($\chi^2 = 22.690$, $P<.001$), educational level ($\chi^2 = 45.197$, $P<.001$), average monthly household income per capita ($\chi^2 = 221.572$, $P<.001$), employment status ($\chi^2 = 97.593$, $P<.001$), residence ($\chi^2 = 37.908$, $P<.001$), payment method for medical expenses ($\chi^2 = 49.173$, $P<.001$), surgical history ($\chi^2 = 7.838$, $P = .049$), history of stoma ($\chi^2 = 9.562$, $P = .023$), disease duration ($\chi^2 = 13.535$, $P = .035$), round of chemotherapy ($\chi^2 = 14.486$, $P = .025$), illness perception ($F = 16.844$, $P<.001$), and family function ($F = 2.675$, $P = .047$) statistically significant across the four latent profiles of FT among CRC chemotherapy patients ($P < 0.05$) (Table 2).

Using the latent categories of FT among CRC chemotherapy patients as the dependent variable and the "High FT Profile" as the reference group, 12 variables that were statistically significant in the univariate analysis were included as independent variables. A parallelism test was conducted ($P < .001$), and the conditions for the parallelism test were not met ($P > .05$). Therefore, unordered multinomial logistic regression analysis was employed, with a stepwise method used for variable selection. The model fit information indicated $\chi^2 = 2335.591$, $P < .001$, Cox & Snell $R^2 = 0.624$, and Nagelkerke $R^2 = 0.676$, demonstrating a good fit.[42] The results of the unordered multinomial logistic regression analysis revealed that age group (OR = 0.255, 95% CI = 0.072-0.901, $P = .034$), average monthly household income per capita (OR = 0.046, 95% CI = 0.012-0.172, $P<.001$), employment status (OR = 0.174, 95% CI = 0.066-0.459, $P<.001$), disease duration (OR = 4.045, 95% CI = 1.061-15.418, $P = .041$), round of chemotherapy (OR = 0.309, 95% CI = 0.102-0.938, $P = .038$), illness perception (OR = 0.957, 95% CI = 0.917-0.999, $P = .047$), and family function (OR = 1.129, 95% CI = 1.001-1.273, $P = 0.049$) are significant factors influencing the latent categories of FT among CRC patients (Table 3).

Among sociodemographic variables, patients with CRC undergoing chemotherapy aged 18 to 59 years with a household per capita monthly income below $687 are more likely to be classified into the high FT group. Furthermore, compared to retired patients, those who are employed or unemployed are more likely to belong to the high FT group. In terms of disease-related variables, patients with a disease duration of less than 1 year are more likely to be classified into the moderate FT-low psychological adaptation group. Additionally, patients who have undergone 5 to 8 chemotherapy sessions are more likely to be classified into the high FT group. Patients with high levels of illness perception are more likely to belong to the high FT group. Conversely, those with better family functioning are more likely to belong to the moderate FT-high psychological adaptation group and the low FT group.

Discussion

This study categorized FT into four profiles using LPA: high FT group, moderate FT-low psychological adaptation group, moderate FT-high psychological adaptation group, and low FT group, representing 44.5%, 22.8%, 18.0%, and 14.7% of the sample, respectively. A significant proportion of patients with CRC undergoing chemotherapy in this study experienced high levels of FT, which was higher than reported in the study by Hakki.[43] This suggests that the FT levels in most patients with CRC undergoing chemotherapy need to be mitigated. Given that FT is a side effect of disease treatment, healthcare providers should prioritize this issue and implement effective measures to address the challenges faced by patients with high FT.

Age, employment status, and average monthly household income per capita were identified as the significant predictors of potential FT profiles in patients with CRC undergoing chemotherapy (All the *p*-values were less than .05). Firstly, the results of this study indicate that compared with the reference group aged 70 to 89, patients aged 18 to 59 were more likely to be classified into the high-level FT group.[43,44] According to the World Health Organization's age classification, individuals aged 18 to 59 are considered to be part of the young and middle-aged group. This group often serves as the primary economic providers for their families, bearing dual responsibilities of raising children and supporting elderly parents, leading to higher baseline expenses and lower asset accumulation.[45] Therefore, young and middle-aged patients are more susceptible to higher levels of FT. Secondly, patients with CRC undergoing chemotherapy who are employed or unemployed are more likely to fall into the high FT group compared with those who are retired. Due to the high costs of antineoplastic drugs, multiple treatment plans, and extended treatment durations, financial issues faced by patients are becoming increasingly prominent. Unemployed patients without any source of income may experience more severe FT.[46] Employed patients undergoing chemotherapy also face financial challenges, as the effects of the disease often lead to reduced work capacity, resulting in fewer working hours and an increased need for rest, which directly impacts their income.[47] In contrast, China's pension insurance system serves as a social security mechanism that provides economic support to

Table 2
Differences in Demographic and Continuous Variables Among Latent Profiles

Variables	Categories	Profile 1 n (%)	Profile 2 n (%)	Profile 3 n (%)	Profile 4 n (%)	Statistics	*P* value
Gender	Male	104 (62.7)	58 (68.2)	49 (73.1)	42 (76.4)	4.746[a]	.191
	Female	62 (37.3)	27 (31.8)	18 (26.9)	13 (23.6)		
Age group	18-59 y	104 (62.7)	44 (51.8)	24 (35.8)	19 (34.5)	22.690[a]	<.001**
	60-69 y	45 (27.1)	27 (31.7)	29 (43.3)	22 (40)		
	70-89 y	17 (10.2)	14 (16.5)	14 (20.9)	14 (25.5)		
Marital status	Married	154 (92.8)	75 (88.2)	65 (97)	52 (94.5)	7.383[b]	.199
	Unmarried	1 (0.6)	0 (0.0)	0 (0.0)	1 (1.8)		
	Divorce or widowed	11 (6.6)	10 (11.8)	2 (3)	2 (3.6)		
Educational level	Primary school or below	63 (38)	31 (36.5)	18 (26.9)	11 (20)	45.197[a]	<.001**
	Junior high school	72 (43.4)	26 (30.6)	20 (29.9)	17 (30.9)		
	High school or vocational school	19 (11.4)	16 (18.8)	16 (23.8)	5 (9.1)		
	College or above	12 (7.2)	12 (14.1)	13 (19.4)	22 (40.0)		
Average monthly household Income per capita, USD	<412	125 (75.3)	27 (31.8)	13 (19.4)	1 (1.8)	221.572[a]	<0.001**
	412-686	38 (22.9)	44 (51.7)	21 (31.3)	7 (12.7)		
	>687	3 (1.8)	14 (16.5)	33 (49.3)	47 (85.5)		
Employment status	Working	28 (16.8)	26 (30.6)	7 (10.5)	11 (20.0)	97.593[a]	<0.001**
	Not working	113 (68.1)	27 (31.8)	24 (35.8)	4 (7.3)		
	Retired	25 (15.1)	32 (37.6)	36 (53.7)	40 (72.7)		
Residence	City	66 (39.8)	44 (51.8)	47 (70.1)	45 (81.8)	37.908[a]	<0.001**
	Rural area or Town	100 (60.2)	41 (48.2)	20 (29.9)	10 (18.2)		
Number of children	None	4 (2.4)	1 (1.2)	0 (0.0)	1 (1.8)	4.832[b]	0.531
	One	83 (50.0)	48 (56.5)	41 (61.2)	34 (61.8)		
	Two or more	79 (47.6)	36 (42.4)	26 (38.8)	20 (36.4)		
Tumor stages	II or below	28 (16.9)	18 (21.2)	16 (24.2)	9 (16.4)	3.858[a]	0.696
	III	49 (29.5)	28 (32.9)	20 (30.2)	21 (38.2)		
	IV	89 (53.6)	39 (45.9)	31 (45.6)	25 (45.4)		
History of stoma	Yes	22 (13.3)	2 (2.4)	11 (16.4)	8 (14.5)	9.562[a]	0.023*
	No	144 (86.7)	83 (97.6)	56 (83.6)	47 (85.5)		
Surgical history	Yes	97 (58.4)	34 (40.0)	33 (49.3)	28 (50.9)	7.838[a]	0.049*
	No	69 (41.6)	51 (60.0)	34 (50.7)	27 (49.1)		
Chronic comorbidities	Yes	58 (34.9)	35 (41.2)	29 (43.3)	23 (41.8)	2.020[a]	0.568
	No	108 (65.1)	50 (58.8)	38 (56.7)	32 (58.2)		
Disease duration	Half a year or below	68 (41.0)	35 (41.2)	37 (55.2)	24 (43.6)	13.535[a]	0.035*
	Half to one year	44 (26.5)	35 (41.2)	17 (25.4)	15 (27.3)		
	More than one years	54 (32.5)	15 (17.6)	13 (19.4)	16 (29.1)		
Round of chemotherapy	1-4	79 (47.6)	41 (48.3)	48 (71.7)	24 (43.6)	14.486[a]	0.025*
	5-8	52 (31.3)	24 (28.2)	11 (16.4)	20 (36.4)		
	More than 8	35 (21.1)	20 (23.5)	8 (11.9)	11 (20.0)		
Payment method for medical expenses	NCMS	86 (51.8)	37 (43.5)	14 (20.9)	5 (9.1)	49.173[a]	<0.001**
	URBMI	33 (19.9)	16 (18.9)	14 (20.9)	11 (20.0)		
	UEBMI	47 (28.3)	32 (37.6)	39 (58.2)	39 (70.9)		
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Illness perception		44.08±8.85	40.00±6.75	37.01±9.10	36.95±8.81	16.844[c]	<0.001**
Family function		7.67±2.84	7.95±2.53	8.45±2.37	8.64±2.13	2.675[c]	0.047*

NCMS, New Rural Cooperative Medical system; URBMI, Urban Residents' Basic Medical Insurance; UEBMI, Urban Employee Basic Medical Insurance.
[a] Chi-square test;
[b] Fisher exact probability;
[c] The one-way ANOVA;
* $p < .05$;
** $p < .001$.

retirees through mandatory or voluntary contributions.[48] As a result, retired patients in this study may experience lower levels of FT due to the stable income provided by the pension scheme. Thirdly, this study showed that patients with CRC undergoing chemotherapy with a per capita monthly household income of less than $687 were more likely to be classified into the high FT group. The results of this study are consistent with the findings of Sadigh et al.[49] A study found that the financial burden for low-income patients was 5.86 times greater than that of high-income patients.[50] Studies from the United States and Japan have demonstrated a correlation between low-income and increased severity of FT.[51,52] Low-income patients often face challenges in accessing early disease screening, timely diagnosis, treatment, and regular follow-ups, which can lead to further deterioration in health, elevated medical and care costs, and heightened FT.[53] Subsequently, healthcare providers should particularly focus on middle-aged and younger patients, whether employed or unemployed, who have lower per capita household income. It is crucial to engage in comprehensive and proactive communication with patients regarding treatment plans and decisions. This approach can aid in effectively planning the treatment process, reducing the impact of chemotherapy on patients' daily lives and work, and maximizing their functional recovery.[54]

In this study, disease duration and the round of chemotherapy were identified as predictive factors for the FT profile in patients with CRC undergoing chemotherapy (the *P*-values were all less than .05). Compared with patients with a disease duration of over 1 year, those with a duration of less than 6 months or between 6 months and 1 year were more likely to be categorized into the moderate FT -low psychological adaptation group. Smith et al argue that the financial burden is most severe in the early stages of cancer treatment.[55] However, this study's findings opposite the above conclusion, possibly due to differences in healthcare systems between countries. In countries with comprehensive healthcare systems, such as those offering universal health coverage, patients' financial burdens may be reduced during the early stages of treatment, as they can access subsidies or receive reimbursements for most initial treatment costs.[56] In contrast, in countries with limited insurance coverage, like China, patients often bear a larger share of treatment expenses, particularly

Table 3
Multinomial Logistic Regression Analysis of Factors Influencing the Potential Profiles of FT

Variables	Profile 1 vs Profile 2				Profile 1 vs Profile 3				Profile 1 vs Profile 4			
	β	*P*	OR	OR 95% CI	β	*P*	OR	OR95%CI	β	*P*	OR	OR 95% CI
Age group (Reference: 70-89 y)												
18~59 y	-0.579	.321	0.561	0.178-1.760	-1.366	.034	0.255	0.072-0.901	-1.337	.121	0.263	0.049-1.421
60-69 y	-0.879	.141	0.415	0.129-1.338	-0.699	.256	0.497	0.149-1.659	-0.941	.241	0.390	0.081-1.879
Educational Level (Reference: College or above)												
Primary school or below	0.347	.607	1.415	0.377-5.304	0.539	.490	1.714	0.371-7.914	0.563	.540	1.756	0.290-10.643
Junior high school	0.049	.940	1.051	0.290-3.807	0.468	.540	1.597	0.358-7.127	0.764	.368	2.146	0.407-11.307
High school or vocational school	0.574	.385	1.775	0.486-6.475	0.779	.305	2.179	0.491-9.665	-0.545	.538	0.580	0.102-3.281
Average Monthly Household Income Per Capita, USD (Reference: >687)												
<412	-3.073	<.001***	0.046	0.012-0.172	-4.661	<.001***	0.009	0.003-0.035	-7.580	<.001***	0.001	0.003-0.005
412-686	-1.394	.039*	0.248	0.066-0.929	-2.991	<.001***	0.050	0.014-0.184	-4.443	<.001***	0.012	0.003-0.049
Employment Status (Reference: Retired)												
Working	-0.321	.400	0.725	0.344-1.532	-1.751	<.001***	0.174	0.066-0.459	-1.404	<.001***	0.246	0.104-0.579
Not working	-1.678	<.001***	0.187	0.095-0.365	-1.914	<.001***	0.147	0.075-0.289	-3.811	<.001***	0.022	0.007-0.067
Residence (Reference: Rural area or Town)												
City	0.411	.313	1.508	0.679-3.349	0.329	.475	1.390	0.563-3.429	0.314	.646	1.369	0.358-5.232
History of Stoma (Reference: No)												
Yes	-1.738	.051	0.176	0.031-1.006	0.095	.892	1.100	0.278-4.345	0.210	.820	1.234	0.201-7.590
Surgical History (Reference: No)												
Yes	-0.415	.255	0.660	0.323-1.349	-0.621	.147	0.537	0.232-1.244	-0.029	.960	0.971	0.312-3.020
Disease Duration (Reference: More than 1 y)												
Half a year or below	1.398	.041*	4.045	1.061-15.418	0.392	.602	1.480	0.339-6.472	0.518	.593	1.679	0.251-11.236
Half to one year	2.070	<.001***	7.924	2.527-24.847	0.642	.343	1.900	0.505-7.150	0.419	.611	1.520	0.303-7.624
Round of Chemotherapy (Reference: More than 8)												
1-4	-1.035	.123	0.355	0.095-1.326	0.864	0.283	2.373	0.490-11.493	-0.035	0.973	0.965	0.126-7.370
5-8	-1.174	.038	0.309	0.102-0.938	-0.247	0.735	0.781	0.188-3.253	1.019	0.266	2.769	0.459-16.693
Payment Method for Medical Expenses (Reference: UEBMI)												
NCMS	0.598	.285	1.818	0.608-5.435	-0.156	0.812	0.856	0.237-3.091	0.535	0.590	1.708	0.244-11.947
URBMI	-0.097	.853	0.908	0.324-2.542	0.215	0.703	1.240	0.411-3.741	0.784	0.312	2.190	0.479-10.007
Illness Perception	-0.044	.047*	0.957	0.917-0.999	-0.092	<0.001***	0.912	0.867-0.960	-0.093	0.007**	0.911	0.852-0.975
Family function	0.038	.442	1.039	0.943-1.145	0.121	0.049*	1.129	1.001-1.273	0.162	0.024*	1.176	1.022-1.354

Profile 1:High FT Profile.
Profile 2:Moderate FT- Low Psychological Adaptation Profile.
Profile 3:Moderate FT- High Psychological Adaptation Profile.
Profile 4:Low FT Profile.
NCMS, New Rural Cooperative Medical system; URBMI, Urban Residents' Basic Medical Insurance; UEBMI, Urban Employee Basic Medical Insurance;
* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$.

for costly procedures such as surgery, radiotherapy, chemotherapy, and targeted therapies.[57] Over time, these accumulating costs can result in significant financial strain for patients with longer treatment durations. Furthermore, differences in payment schedules, reimbursement processes, and out-of-pocket costs across healthcare systems can contribute to delayed financial burdens for patients in certain regions.[58] Patients with a shorter duration of illness may still be experiencing psychological reactions such as shock, denial, and depression. They may not have fully accepted their condition and may not have physically adjusted to the side effects of chemotherapy, leading to lower levels of psychological adaptation. Additionally, Knight et al.[59] suggest that the more complex the treatment plan and the longer the treatment duration, the higher the medical costs patients incur. In this study, patients who underwent 5 to 8 rounds of chemotherapy were more likely to be categorized into the high FT group. CRC chemotherapy is characterized by multiple cycles and dimensions, with periodic accumulation of treatment costs and reduced individual productivity contributing to the development of FT.[60] Therefore, in clinical practice, healthcare providers should focus on patients with longer disease durations and more frequent chemotherapy sessions. They should employ comprehensive measures such as offering appropriate treatment plans, enhancing guidance on the utilization of health insurance policies, providing information on financial assistance, and offering psychological support to reduce patients' FT.

This study found that illness perception is a risk factor for FT among patients with CRC undergoing chemotherapy. Patients with a heightened level of illness perception are more likely to experience higher levels of FT. Previous research has demonstrated that psychosocial factors have a substantial impact on FT, indicating that out-of-pocket expenses are not the only contributing factor.[61] This further supports the concept of FT, which encompasses both objective financial burden and subjective economic distress.[15] A cross-sectional study by Yang indicated that patients with a higher level of illness perception are more likely to experience significant anxiety about cancer and adopt a negative attitude toward the disease.[62] Based on these findings, we hypothesize that patients in our study with heightened illness perception may face increased FT due to excessive concern about cancer-related issues, which may, in turn, lead to greater attention to treatment costs. For instance, patients may undergo frequent and unnecessary tests and treatments due to fears of disease recurrence or choose expensive medications and therapies due to unrealistic expectations of treatment outcomes, thereby increasing their subjective financial burden.[63] Some scholars have pointed out that negative illness perception in patients with cancer is a continuous process, and scientific knowledge about the disease plays a crucial role in this process.[64] This represents an intervention at the cognitive level of illness perception. Therefore, healthcare providers should pay attention to patients' illness perception by providing scientific disease knowledge, positive psychological support, and effective financial assistance. These measures can help patients develop a positive and proactive understanding of their illness, thereby reducing FT and improving their quality of life.

In our study, family function was identified as a protective factor against FT in patients with CRC undergoing chemotherapy. Compared to the high FT group, patients who received more family care experienced relatively lower levels of FT, consistent with the findings of Shao et al.[32] Research indicates that cancer-related FT is linked to patients' and families' awareness, preparedness, and coping strategies.[65] Family function, as a core component of a patient's social support network, can effectively alleviate economic and psychological stress through emotional support, practical assistance, and information sharing.[26] Therefore, individuals with higher levels of family support often exhibit greater family cohesion and a sense of belonging, which can enhance patients' confidence in managing FT and significantly reduce the impact of financial stress on them.[66] It is noteworthy that patients may need to frequently travel to and from the hospital during chemotherapy intervals for various tests and treatments, which undoubtedly increases the family's financial burden. Nevertheless, family members can effectively mitigate the patient's physical and psychological burdens by sharing household chores, attending to daily needs, and assisting with medical affairs, thus allowing the patient to focus more on treatment and recovery. This substantial support from the family not only reduces the patient's direct financial pressure but also enhances their quality of life and reduces indirect economic losses caused by the illness.[67] Therefore, healthcare providers should prioritize the assessment and support of family care, offering family counseling and educational interventions to strengthen the family's support function and mitigate the negative effects of FT on patients.

Strength and Limitation

The strength of this study lies in its use of LPA to reveal the heterogeneity of FT among different groups of CRC chemotherapy patients. This method captures individual differences more effectively than traditional statistical analyses. Moreover, the study not only focuses on FT itself but also considers psychological and social factors such as illness perception and family functioning. This comprehensive analysis helps us understand the relationship between FT and patients' overall quality of life, thereby providing more holistic care strategies. By thoroughly analyzing the influencing factors of patients with varying levels of FT, robust evidence can be provided to policymakers, medical institutions, and social organizations. This evidence can promote the reallocation of relevant policies and resources, aiming to alleviate the economic burden on disadvantaged patients.

This study has several limitations. Firstly, due to time and manpower constraints, the study was only conducted in the oncology wards of three tertiary hospitals, limiting the representativeness and generalizability of the results. Future studies should increase the sample size and include multicenter investigations across various regions to enhance external validity. Secondly, the study relied on a self-report questionnaire, which may have introduced recall bias. It is worth noting that the researchers assisted a total of 14 visually impaired patients in completing the questionnaires. Although neutral and non-suggestive language was used, this may have introduced a certain degree of personal bias to the study results. A mixed-methods approach combining quantitative and qualitative data is recommended for future research to provide a more comprehensive understanding of patients' experiences with FT. Thirdly, the study did not distinguish between different subtypes of CRC and chemotherapy regimens, underlining the need for future research to assess the specific impacts of various cancer types and treatment protocols on FT. Finally, the study's cross-sectional design and short duration limited the ability to observe changes in FT over time. Future research should employ longitudinal studies to evaluate the long-term effects of FT on patients with CRC undergoing chemotherapy.

Implications for Nursing Practice

Our study reveals four latent profiles of FT among patients with CRC undergoing chemotherapy. These profiles are influenced by factors such as age, household per capita monthly income, employment status, disease duration, round of chemotherapy, illness perception, and family function. However, currently in China, there are no interventions targeting FT among patients with cancer. Therefore, our findings suggest that oncology specialist nurses should consider patient heterogeneity and develop personalized FT interventions. Incorporating the COST-PROM scale into clinical assessments facilitates the early identification of patients' FT levels. After evaluating FT levels, nurses can implement targeted interventions, including referring patients to financial counseling services, providing information on available financial aid programs, or collaborating with the healthcare team to adjust treatment plans to reduce financial burdens without compromising efficacy. Additionally, assessing FT enables nurses to educate patients on financial literacy and emphasize the importance of participating in cost discussions. These interventions not only enhance patients' financial well-being but also encourage active participation in treatment decisions, improving adherence and quality of life. By assessing FT, nurses gain a deeper understanding of the financial challenges patients face, enabling them to initiate timely interventions to mitigate FT's impact on treatment adherence and outcomes. This proactive approach empowers patients to prepare financially, ensuring they can access necessary treatments without undue financial stress.

Conclusions

In this study, LPA was used to divide the FT of patients with CRC undergoing chemotherapy into high FT group, moderate FT-low psychological adaptation group, moderate FT-high psychological adaptation group, and low FT group, respectively. This study also identified age, average monthly household income per capita, employment status, disease duration, round of chemotherapy, illness perception score, and family function score as predictors of FT among different characteristics. Knowing demographic variables such as age, average monthly household income per capita, and employment status can help healthcare providers better identify patients with high FT. In addition, healthcare providers should guide patients to develop a positive perception of the disease and instruct families on how to provide the necessary care and support to reduce the subjective FT levels that patients experience.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Fangyi Li: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Tian Xiao:** Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Chunmei Liu:** Writing – review & editing, Supervision, Resources, Project administration, Investigation. **Qiumei Ma:** Writing – original draft, Investigation, Formal analysis, Data curation. **Xiaoli Huang:** Writing – original draft, Supervision, Formal analysis, Data curation. **Xueqin Qiu:** Software, Methodology. **Linyu Zhou:** Software, Methodology. **Ruihan Xiao:** Visualization. **Xiaoju Chen:** Writing – review & editing, Writing – original draft, Supervision, Project administration.

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Supplementary materials

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