Asia-Pacific Journal of Oncology Nursing 11 (2024) 100552

Contents lists available at ScienceDirect

Asia-Pacific Journal of Oncology Nursing

journal homepage: www.apjon.org

Original Article

# Influence of age on financial toxicity in cancer patients

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ARTICLE INFO

*Keywords:*
Financial toxicity
Cancer
Age
Oncology
Healthcare

ABSTRACT

*Objective:* The aim of this study was to assess the level of financial toxicity (FT) experienced by the following three age groups of cancer patients in China: young working-aged patients (age < 40 years), middle-aged patients (40–64 years), and older patients (≥ 65 years).

*Methods:* The data used for this study were collected via a cross-sectional survey conducted in China. FT was assessed using the Comprehensive Score for Financial Toxicity (COST). ANOVA was used to examine the differences in FT status between age groups. Multivariate linear regression models were employed to assess the association between age and FT, adjusted by socioeconomic and other clinical characteristics.

*Results:* A total of 556 cancer patients completed the survey. Approximately 54.3% of the participants were male and 45.7% were female. The majority (61.5%) were aged 40–64 years, while 27.7% were aged 65 or older. The mean FT scores for young patients (< 40 years), middle-aged patients (40–64 years), and older patients (≥ 65 years) were 16.7, 12.8, and 12.4, respectively. The results of the regression analysis revealed that, without adjusting for background characteristics, young patients had significantly higher mean COST scores. This suggests they experienced lower levels of FT compared to patients in other age groups. Stratified analysis revealed that, for older patients, only educational level and type of insurance scheme were significant factors in predicting the COST score.

*Conclusions:* This study provides empirical evidence for developing targeted interventions and policies to reduce the FT for patients in different age groups. Given that FT is complicated, a longitudinal study should be conducted to explore the long-term impact of FT on cancer patients' quality of life and well-being.

## Introduction

Financial toxicity (FT) is a concept that describes the unintended, but not necessarily unanticipated, objective financial burden and subjective financial distress experienced by cancer survivors as a result of their treatment.[1] Although the burden of cancer costs at the health care system level is well recognized, the burden at the individual level, i.e., personal FT, which is associated with the cost of care, is a less well-defined consequence of cancer treatment.[2,3] As a result, the overall financial burden of cancer is being increasingly identified as a priority concern of both cancer patients and the medical providers caring for them.[4,5] The overall financial burden includes direct costs (e.g., the direct cost of care) and indirect costs, the latter of which include objective (e.g., loss of jobs or savings) and subjective (e.g., distress resulting from the financial burden of cancer care) aspects.[4,5] A recent systematic review found that the prevalence of material FT among cancer patients in China was reported by several studies to be over 50%, much higher than the 9% prevalence in the general Chinese population.[6] FT has various negative consequences for cancer patients, including treatment non-adherence, a compromised quality of life, and increased psychological distress.[7–9] It is important to identify the types and sources of FT affecting vulnerable patient subgroups and the impact of FT on their health.

China has undertaken major health care reforms since 2009, in which commendable accomplishments such as expanding insurance coverage, restructuring public hospitals, and strengthening primary care services have been made.[10] Previous research found that out-of-pocket expenses declined by 30% following these reforms, but this decrease was limited to higher income groups.[11] For cancer patients, the financial burden of outpatient care remains high despite the reforms. One study found that cancer patients still had to pay, on average, 42% of outpatient costs themselves, with low-income patients paying over 50%. Another systematic review examining the financial burden on cancer patient

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https://doi.org/10.1016/j.apjon.2024.100552
Received 19 April 2024; Accepted 2 July 2024

households after the 2009 reforms indicated that medical costs accounted for 36.0%–63.1% of their annual household income, with a burden of 51.0% of income seen in a relatively high proportion of families.[12] This indicates that while the reforms have helped alleviate costs for some, they have not sufficiently reduced the financial strain faced by the majority of the patient population.

While the number of FT-related studies in China is increasing, there are still limitations. A systematic review assessing FT in Chinese cancer patients found that few studies used standardized and validated tools for this purpose. The review strongly encouraged the use of such measures to enable comparison of results across studies, both horizontally and vertically.[6] In recent years, the employment of valid tools like the Comprehensive Score for Financial Toxicity (COST) in China has increased, providing more evidence in this field. However, research gaps still exist. For instance, most studies only focus on one type of cancer,[13–15] are conducted in a single center,[16] exclusively target older patients,[17] or are confined to a specific geographic area of China.[18] Although a latest study has explored FT in Chinese cancer patients extensively,[19] such studies are still scarce. Gathering more comprehensive evidence on FT across different regions, cancer types, and age groups within a large sample is essential.

Evidence suggests that cancer patients in different age groups may experience varying degrees of financial burden. Younger cancer patients were reported to be more susceptible to psychosocial distress, which can increase their risk and worsen the consequences of financial hardship. For instance, Corrigan et al. found that younger and middle-aged cancer patients bear a disproportionate FT burden compared with older adults.[20] Lu et al. demonstrated that a younger age at the time of cancer diagnosis is linked to more persistent and severe FT.[21] However, some studies have shown a different picture. Cancer treatment costs can rapidly drain the limited finances of older patients, forcing them to choose between health care and other essential needs. This financial stress can worsen their health, negatively affecting quality of life and treatment results. For instance, studies in Chinese cancer patients have demonstrated an increase in the prevalence of catastrophic health expenditure and post-treatment household impoverishment with age.[22,23] Another study in the US also found a stronger relationship between financial and overall distress in a middle-aged group than a younger group of cancer patients.[24] Nevertheless, most of these studies examined the FT in different age groups did not directly measure the concept of FT. While FT and out-of-pocket health expenditure are related, they are distinct concepts. Both concern the financial impact of health care but differ in focus. FT centers on an individual patient's experience and the subjective burden of their health care costs. Conversely, out-of-pocket health expenditure is a more objective measure, assessing the proportion of household budgets allocated to health care costs at the population level. Therefore, it is crucial to gather empirical evidence to understand the impact of FT on cancer patients.

To develop multidimensional and targeted FT assessment and intervention strategies for future routine implementation in cancer care, a comprehensive analysis of the spectrum, severity, and comparative impact of the various domains of FT among individuals of different age groups is required. Understanding age-related differences in FT can inform those responsible for policies and insurance coverage, allowing them to better address the unique financial challenges faced by different age groups of cancer patients. Therefore, in this study, we aimed to measure and compare age-related FT in Chinese cancer patients.

## Methods

### *Data and participants*

The data used in this study were obtained from a cross-sectional survey conducted in the departments of oncology of two tertiary-level public hospitals (Nanjing and Guangzhou) in China from January to April 2021. Patients were included in the study if they (1) were aged between 18 and 80 years, (2) had no cognitive impairments, (3) were able to complete the questionnaire without assistance, and (4) agreed to provide informed consent. The process of data collection is described in our previous published paper.[25] The study protocol and informed consent were approved by the Human Research Ethics Committee of the Chinese University of Hong Kong (IRB No. SBRE-20-137). We confirm that all methods were performed in accordance with the relevant guidelines and regulations. Informed consent was obtained from all participants.

### *Data collection*

#### *Background characteristics*

We collected information on the respondents' demographic characteristics, including sex (male or female), educational level (no/primary [did not receive any formal education or completed six years of primary-level schooling], secondary [completed junior or senior high school], and tertiary [completed college or higher education]), employment status (active employment or non-active employment), and self-reported annual household income (≤RMB ¥50,000 [USD $7450], RMB ¥50,001–100,000 [USD $14,900], RMB ¥100,001–200,000 [USD $29,800], or ≥RMB ¥200,001). Information on medical insurance in China was also collected, of which there are three main types: Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI), and New Rural Cooperative Medical Scheme (NRCMS). The first two primarily cover urban residents, while the last is for rural residents. As of 2021, about 95% of the population in China was covered by medical insurance. The reimbursement rate for cancer varies among these insurance types, but it is generally lower than that for other diseases.[26] Additionally, we requested that participants provide information regarding whether they had purchased commercial insurance.

Clinical data, such as the Eastern Cooperative Oncology Group performance status (ECOG PS) (the ECOG score describes a patient's level of functioning in terms of their self-care ability, daily activity, and physical ability on a scale from 0 to 5; a score of 0 indicates full activity, while a score of 5 indicates death), frequency of hospital admission within last 12 months (once, 2–4 times, or ≥ 5 times), and duration of current cancer (≤ 1 year, 2 years, or ≥ 3 years), were also collected.

Participants' ages were recorded as continuous variables, with each indicating their year and month of birth. To maintain comparability with previous studies, participants were divided into three age groups: young working-age (18–39 years), middle-aged (40–64 years), and older (≥ 65 years). This categorization follows the criteria applied in a previous cancer study using the national mortality surveillance system of China.[27]

#### *Financial toxicity*

The COST scale was used to assess FT in cancer patients.[28] The COST scale consists of 12 items related to the costs of services and medications, resources and savings, and financial concerns.[14] Each item is measured on a 5-point Likert scale (0 = not at all, 4 = very much). The overall COST score is calculated based on the first 11 items only, while the last item is used to independently measure overall financial well-being. Items 2, 3, 4, 5, 8, 9, and 10 require a reversed score. A higher COST score indicates a lower degree of FT.[29] The psychometric properties of the COST scale in the Chinese population were reported by Yu et al.[30]

### *Statistical analysis*

Descriptive statistics were used to summarize the background characteristics of all participants. Depending on the distribution of continuous variables, mean and standard deviation or median and first/third quartile (Q1-Q3) were calculated to describe data, while categorical variables are presented as the frequency and proportion. The *t* test (two-group comparison) and Analysis of Variance (ANOVA, multi-group comparison) were used to examine differences in FT across various background characteristics and age groups.

Multivariate generalized linear regression models were used to test the associations between age and overall FT. Five models were developed in this study. The first model, the age-only model, used COST as the dependent variable and age as the sole independent variable. The second model was an age-adjusted model, with COST as the dependent variable and age and all other background and clinical characteristics as independent variables. Both models used the "enter" method, meaning that all variables were entered into the analysis simultaneously. The third, fourth, and fifth models were young, middle-aged, and older patient models, respectively. For these, COST was the dependent variable and all background and clinical characteristics were independent variables. The stepwise method was used to select variables to be added to the models step-by-step to develop the final models. Only those categories of variables that were statistically significant were represented in the final model. The "cancer stage" variable and the "commercial insurance" category of the insurance variable were not included in the model. This is because more than half of the patients did not provide cancer stage information, and very few participants were covered by commercial insurance. The regression coefficient and 95% confidence interval (95% CI) were determined. The listwise deletion method was used to account for missing data. R software was used to perform all data analyses. A *P*-value of less than 0.05 was considered statistically significant.

## Results

Table 1 presents the demographic and clinical characteristics of the study population. The surveyed population consisted of 556 individuals, with 54.3% being male and 45.7% female. The majority of participants (61.5%) were aged 40–64, with 27.7% being 65 or older. In terms of education, 56.4% had received a secondary-level and 19.6% a tertiary-level or higher education. The group with an ECOG PS score of 0 had the largest number of participants (48.7%). The most common hospitalization frequency was 5 or more times (37.9%), and the majority of participants (40.5%) had a cancer stage of III–IV. Approximately 46.9% of participants had been diagnosed with cancer for 2 years.

Table 2 displays the demographic and health-related factors associated with FT (COST score), both overall and stratified by age group. Overall, younger patients (mean = 16.7 [SD = 10.2], $P = 0.002$) had a statistically higher COST score than middle-aged (mean = 12.8 [SD = 8.2]) and older patients (mean = 12.4 [SD = 7.6]). Patients with a higher educational level, active employment, and higher personal income had higher COST scores. Regarding the clinical characteristics, we found that patients with a lower ECOG score, fewer hospitalizations, and shorter hospital stays had significantly higher COST scores. The differences in COST scores between the various demographic and clinical groups within each age group are presented in Table 1. The median and Q1/Q3 values of the COST scores are reported in Appendix Table A1.

Appendix Table A2 presents the responses to each item on the COST questionnaire, as classified by age group. Young patients generally scored higher on the majority of COST items (9/12), including item 12, the overarching item, than the other two age groups. However, for the statements "I am satisfied with my current financial situation", "I feel financially stressed" (reversed score), and "I am concerned about keeping my job and income, including paid work at home" (reversed score), middle-aged patients scored significantly lower than older patients.

**Table 1**
Patient's background characteristics stratified by age groups.

| Characteristics | Overall | | < 40 years (*n* = 60) | | 40-64 years (*n* = 342) | | ≥ 65 years (*n* = 154) | | *P*-value |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | *n* | % | |
| Sex (*n* = 556) | | | | | | | | | 0.002 |
| Male | 302 | 54.3 | 23 | 38.3 | 180 | 52.6 | 99 | 64.3 | |
| Female | 254 | 45.7 | 37 | 61.7 | 162 | 47.4 | 55 | 35.7 | |
| Educational level (*n* = 555) | | | | | | | | | < 0.001 |
| No/primary | 133 | 24.0 | 2 | 3.3 | 69 | 20.2 | 62 | 40.3 | |
| Secondary | 313 | 56.4 | 21 | 35.0 | 211 | 61.9 | 81 | 52.6 | |
| Tertiary and above | 109 | 19.6 | 37 | 61.7 | 61 | 17.9 | 11 | 7.1 | |
| Employment (*n* = 556) | | | | | | | | | < 0.001 |
| Active | 148 | 26.6 | 37 | 61.7 | 105 | 30.7 | 6 | 3.9 | |
| Non-active | 408 | 73.4 | 23 | 38.3 | 237 | 69.3 | 148 | 96.1 | |
| Medical insurance (*n* = 538) | | | | | | | | | 0.808 |
| UEBMI | 243 | 45.2 | 29 | 49.2 | 153 | 46.1 | 61 | 41.5 | |
| URBMI | 86 | 16.0 | 11 | 18.6 | 51 | 15.4 | 24 | 16.3 | |
| NCMS | 204 | 37.9 | 19 | 32.2 | 124 | 37.3 | 61 | 41.5 | |
| Commercial insurance | 5 | 0.9 | 0 | 0.0 | 4 | 1.2 | 1 | 0.7 | |
| Personal annual income (*n* = 556) | | | | | | | | | < 0.001 |
| ≤ 50,000 RMB (USD 7450) | 310 | 55.8 | 21 | 35.0 | 192 | 56.1 | 97 | 63.0 | |
| 50,001–100,000 RMB (USD 14,900) | 154 | 27.7 | 17 | 28.3 | 95 | 27.8 | 42 | 27.3 | |
| 100,001–200,000 RMB (USD 29,800) | 55 | 9.9 | 12 | 20.0 | 35 | 10.2 | 8 | 5.2 | |
| ≥ 200,001 RMB | 37 | 6.7 | 10 | 16.7 | 20 | 5.8 | 7 | 4.5 | |
| ECOG PS (*n* = 556) | | | | | | | | | 0.016 |
| 0 | 271 | 48.7 | 40 | 66.7 | 167 | 48.8 | 64 | 41.6 | |
| 1 | 237 | 42.6 | 18 | 30.0 | 142 | 41.5 | 77 | 50.0 | |
| ≥ 2 | 48 | 8.6 | 2 | 3.3 | 33 | 9.6 | 13 | 8.4 | |
| Frequency of hospitalization (times) (*n* = 552) | | | | | | | | | 0.003 |
| 1 | 146 | 26.6 | 26 | 43.3 | 92 | 27.2 | 28 | 18.2 | |
| 2-4 | 197 | 35.7 | 21 | 35.0 | 116 | 34.3 | 60 | 39.0 | |
| ≥ 5 | 209 | 37.9 | 13 | 21.7 | 130 | 38.5 | 66 | 42.9 | |
| Cancer staging (*n* = 556) | | | | | | | | | 0.590 |
| I-II | 82 | 14.7 | 9 | 15.0 | 47 | 13.7 | 26 | 16.9 | |
| III-IV | 225 | 40.5 | 20 | 33.3 | 146 | 42.7 | 59 | 38.3 | |
| Uncertain | 249 | 44.8 | 31 | 51.7 | 149 | 43.6 | 69 | 44.8 | |
| Duration (year) (*n* = 556) | | | | | | | | | 0.331 |
| ≤ 1 | 92 | 16.5 | 14 | 23.3 | 58 | 17.0 | 20 | 13.0 | |
| 2 | 260 | 46.8 | 29 | 48.3 | 159 | 46.5 | 72 | 46.8 | |
| ≥ 3 | 204 | 36.7 | 17 | 28.3 | 125 | 36.5 | 62 | 40.3 | |

*P*-values were estimated based on Chi-squared test.
UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme; ECOG PS, Eastern Cooperative Oncology Group performance status.

**Table 2**
Patient's FT profile stratified by age groups.

| | < 40 years | | 40–64 years | | ≥ 65 years | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | *P*-value | Mean (SD) | *P*-value | Mean (SD) | *P*-value | Mean (SD) | *P*-value |
| | | | | | | | 13.1 (8.4) | |
| **Age (years)** | | | | | | | | |
| < 40 | | | | | | | 16.7 (10.2) | 0.002 |
| 40-64 | | | | | | | 12.8 (8.2) | |
| ≥ 65 | | | | | | | 12.4 (7.6) | |
| **Sex** | | | | | | | | |
| Male | 17.2 (9.8) | 0.80 | 13.4 (8.6) | 0.16 | 12.6 (8.0) | 0.64 | 13.4 (8.5) | 0.38 |
| Female | 16.5 (10.6) | | 12.2 (7.8) | | 12.1 (7.1) | | 12.8 (8.2) | |
| **Educational level** | | | | | | | | |
| Primary | 11.5 (12) | 0.16 | 11.5 (7.8) | <0.001 | 10.7 (7.3) | <0.001 | 11.1 (7.6) | <0.001 |
| Secondary | 13.8 (8.7) | | 12.0 (7.7) | | 12.7 (7.6) | | 12.3 (7.7) | |
| Tertiary and above | 18.7 (10.6) | | 17.0 (9.3) | | 19.7 (5.7) | | 17.9 (9.5) | |
| **Employment** | | | | | | | | |
| Active | 19.40 (10.49) | 0.02 | 15.0 (9.0) | <0.001 | 7.5 (5.6) | <0.001 | 15.8 (9.6) | <0.001 |
| Non-active | 12.43 (8.15) | | 11.8 (7.7) | | 12.6 (7.7) | | 12.2 (7.7) | |
| **Medical insurance** | | | | | | | | |
| UEBMI | 20 (11) | 0.03 | 14 (9) | 0.1 | 14.0 (8.0) | <0.001 | 14.5 (8.9) | <0.001 |
| URBMI | 17 (8) | | 12 (7) | | 15 (7) | | 13.3 (7.2) | |
| NCMS | 11 (8) | | 12 (8) | | 9 (7) | | 10.9 (7.5) | |
| Commercial insurance | – | | 20 (13) | | 9 (–) | | 17.4 (12.0) | |
| **Personal annual income (RMB)** | | | | | | | | |
| ≤ 50,000 | 9.2 (7.2) | <0.001 | 10.7 (7.1) | <0.001 | 11.3 (7.5) | 0.06 | 10.7 (7.2) | <0.001 |
| 50,001–100,000 | 15.9 (7.4) | | 13.5 (7.7) | | 14.1 (7.4) | | 13.9 (7.6) | |
| 100,001–200,000 | 24 (8.7) | | 18.0 (8.8) | | 13.4 (8.6) | | 18.6 (9.2) | |
| ≥ 200,001 | 25.3 (9.4) | | 20.7 (10.3) | | 17.6 (7.3) | | 21.3 (9.7) | |
| **ECOG PS** | | | | | | | | |
| 0 | 19.0 (9.5) | 0.04 | 14.4 (8.6) | <0.001 | 12.8 (7.3) | 0.86 | 14.7 (8.6) | <0.001 |
| 1 | 12.5 (10.6) | | 11.6 (7.4) | | 12.3 (7.8) | | 11.9 (7.8) | |
| ≥ 2 | 9.0 (2.8) | | 9.8 (8.0) | | 11.6 (8.5) | | 10.3 (7.9) | |
| **Frequency of hospitalization (times)** | | | | | | | | |
| 1 | 18.8 (8.5) | 0.38 | 16.4 (8.4) | <0.001 | 14.0 (7.7) | 0.26 | 16.4 (8.4) | <0.001 |
| 2-4 | 14.9 (11.5) | | 12.4 (7.8) | | 12.9 (7.3) | | 12.8 (8.1) | |
| ≥ 5 | 15.6 (11.1) | | 10.6 (7.6) | | 11.3 (7.9) | | 11.2 (8.0) | |
| **Cancer staging** | | | | | | | | |
| I-II | 19.9 (11.4) | 0.17 | 14.3 (8.2) | 0.001 | 11.9 (6.9) | 0.94 | 14.2 (8.4) | 0.001 |
| III-IV | 14.1 (10.6) | | 10 (7) | | 11.9 (8.0) | | 10.9 (7.7) | |
| **Duration (year)** | | | | | | | | |
| ≤ 1 | 22 (9) | 0.06 | 15 (9) | 0.07 | 13 (7) | 0.07 | 15.7 (8.8) | 0.001 |
| 2 | 16 (11) | | 13 (9) | | 14 (8) | | 13.4 (8.7) | |
| ≥ 3 | 14 (9) | | 12 (7) | | 11 (7) | | 11.5 (7.3) | |

Only one patient with ≥ 65 years reported buying commercial insurance.
*P*-values were estimated based on ANOVA.
UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme; ECOG PS, Eastern Cooperative Oncology Group performance status.

Multivariate linear regression models were estimated to predict FT based on age and the other background and clinical characteristics of our sample. Model 1 demonstrated that age is a significant variable for predicting changes in FT. Younger patients reported a higher COST score than middle-aged (beta = −3.95, 95% CI: −6.23, −1.67, $P < 0.001$) and older patients (beta = −4.31, 95% CI: −6.19, −1.83, $P < 0.001$). However, after adjusting for other background and clinical characteristics, there was no significant association between age and the COST score (Model 2).

Models 3, 4, and 5 examined the relationships between the COST score and various background and clinical characteristics across the different age groups. In younger patients, a higher COST score was significantly associated with a higher personal income and lower ECOG score. For middle-aged patients, a significant relationship was found between lower FT, higher personal income, and less frequent hospitalization. Older patients who completed tertiary education had higher COST scores (beta = 7.04, 95% CI: 2.47, 11.62, $P < 0.001$) than those who completed primary education. However, those covered by NCMS were more likely to have lower COST scores (beta = −5.05, 95% CI: −7.37, −2.73, $P < 0.001$) than those covered by UEBMI (Table 3).

## Discussion

The study findings highlight the varying FT experienced by Chinese cancer patients across different age groups. Overall, compared with the FT reported in previous studies,[14,16,18] the FT in our sample of Chinese cancer patients was higher. The results of the regression analysis revealed that, without adjusting for participants' background characteristics, FT was higher in older and middle-aged patients compared to younger ones. These results align with previous studies that suggested older patients might bear a higher financial burden than their younger counterparts. However, our research has provided further empirical evidence of differences in FT among age groups. Although a recent systematic review indicated that younger cancer patients were at a greater risk of FT than older patients,[31] our findings may still be valid for several reasons. Firstly, even with medical insurance, older adults may encounter significant out-of-pocket costs for treatments not fully covered by their policies, such as certain prescription drugs, long-term care, or experimental therapies.[32] Additionally, not all older adults have substantial amounts of savings or assets. In our sample, older patients had lower

**Table 3**
Results of multivariate linear analysis.

| | beta coefficient (95% confidence interval) | | | | |
|---|---|---|---|---|---|
| | Model 1<br>Age-only model | Model 2<br>Age-adjusted model | Model 3<br>Young patient model | Model 4<br>Middle-aged patient model | Model 5<br>Older patient model |
| **Age (years)** | | | | | |
| < 40 | Reference | Reference | | | |
| 40–64 | -3.95 (-6.23, -1.67)*** | -0.31 (-2.58, 1.97) | | | |
| ≥ 65 | -4.31 (-6.79, -1.83)*** | 0.17 (-2.46, 2.80) | | | |
| **Educational level** | | | | | |
| No/primary | | Reference | | Reference | Reference |
| Secondary | | -0.02 (-1.73, 1.68) | | – | – |
| Tertiary and above | | 2.94 (0.40, 5.47)* | | 3.50 (1.34, 5.65)*** | 7.04 (2.47, 11.62)*** |
| **Employment** | | | | | |
| Active | | Reference | | | |
| Non-active | | 0.19 (-1.52, 1.90) | | | |
| **Medical insurance** | | | | | |
| UEBMI | | Reference | Reference | | Reference |
| URBMI | | 0.20 (-1.75, 2.16) | – | | – |
| NCMS | | -1.49 (-3.21, 0.23)* | -6.50 (-10.71, -2.30)*** | | -5.05 (-7.37, -2.73)*** |
| **Personal annual income (RMB)** | | | | | |
| ≤ 50,000 | | Reference | Reference | Reference | |
| 50,001–100,000 | | 2.13 (0.56, 3.69)** | – | – | |
| 100,001–200,000 | | 5.39 (3.05, 7.72)*** | 10.49 (5.45, 15.52)*** | 3.99 (1.22, 6.76)** | |
| ≥ 200,001 | | 8.31 (5.60, 11.03)*** | 13.3 (7.94, 18.65)*** | 6.54 (2.97, 10.12)*** | |
| **ECOG PS** | | | | | |
| 0 | | Reference | Reference | | |
| 1 | | -1.57 (-2.94, -0.20)* | -5.08 (-9.38, -0.77)** | | |
| ≥ 2 | | -3.05 (-5.46, -0.65)* | – | | |
| **Frequency of hospitalization (times)** | | | | | |
| 1 | | Reference | | Reference | |
| 2-5 | | -1.51 (-3.47, 0.44) | | -3.28 (-5.39, -1.17)*** | |
| > 5 | | -2.88 (-4.96, -0.81)** | | -5.00 (-7.05, -2.95)*** | |
| **Duration (year)** | | | | | |
| ≤ 1 | | Reference | | | Reference |
| 2 | | -0.54 (-2.69, 1.61) | | | – |
| ≥ 3 | | -1.89 (-4.31, 0.52) | | | -4.16 (-6.48, -1.85)*** |
| **Adj R-squared** | 0.02 | 0.21 | 0.47 | 0.16 | 0.21 |
| **AIC** | 3933.60 | 3631.35 | 409.48 | 2217.57 | 977.68 |
| **BIC** | 3946.56 | 3703.96 | 419.87 | 2240.25 | 989.61 |

*P*-values were estimated based on linear regression analysis.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme; ECOG PS, Eastern Cooperative Oncology Group performance status.

personal incomes than younger ones. Those with limited financial resources may struggle with the extra costs of cancer care.[33] Older adults often have other chronic health conditions requiring ongoing treatment, which can further escalate the financial burden of cancer care.[34] Furthermore, older cancer patients may require long-term care services, such as home health aides or assisted living facilities, that can be expensive and are not always covered by their insurance.[35] It's important to note that the difference in FT between the three age groups is insignificant when adjusting for the participants' background characteristics. This aligns with several previous studies.[15,16] It suggests that FT is a complex phenomenon and future longitudinal studies should be conducted to better understand this topic.

In our study, the COST scores of the young and middle-aged patients increased significantly as their income increased, but this trend was not significant in older patients. In other words, older patients had greater subjective FT than patients in the other age groups, and their increased income did not result in greater financial well-being. Similar results have been obtained in other studies. For example, Meeker et al.[24] reported that fewer older patients were in financial distress than patients in other age groups, and their increased financial distress had a much smaller impact on their overall distress. In response to the abovementioned findings, Liu et al. undertook a specific analysis of FT experienced by older patients in China, concluding that, because older patients fear that they cannot afford cancer-related expenses, they view these expenses as catastrophic health expenditures. Moreover, some older patients have expressed that they do not wish to burden their families and, consequently, choose to voluntarily abandon treatment.[36]

A comparison of the overall mean COST scores between middle-aged and older patients showed a negligible difference. However, when we delved deeper into the data, we observed that middle-aged patients scored consistently higher on some COST items than their older counterparts. For example, for the item “my cancer or treatment has reduced my satisfaction with my present financial situation,” middle-aged patients reported a significantly higher score. This finding suggests that the financial implications of cancer or related treatments may resonate more deeply with older Chinese patients, possibly due to the higher likelihood of them having ongoing financial commitments, such as providing down payments for their children's houses.[37] Furthermore, middle-aged patients scored highly on the item “I know that I have enough money in savings, retirement, or assets to cover the costs of my treatment.” It is evident that financial support mechanisms are crucial for older cancer patients to manage their treatment costs. This support can stem from various sources, such as government programs, non-profit organizations, and health care institutions that offer financial counseling and aid. Assuring that older cancer patients have access to these resources can ease the financial burden of cancer treatment, allowing them to concentrate on their recovery and well-being.[18,38,39]

This study found that an individual's educational level significantly impacts FT, especially among older patients. This observation aligns with the conclusions drawn by Yu et al., who noted a positive correlation

between COST score and educational level.[18] Similarly, Arastu et al. discovered that older patients with advanced cancer and lower educational levels were more likely to report FT.[40] Often, individuals with higher education levels have access to supplemental compensation from labor market pension schemes and private insurance plans. In contrast, those with lower educational levels usually engage in physically demanding work, which can be particularly challenging for patients whose physical strength has been impacted by cancer and cancer treatments.[41] These individuals, already struggling financially, have limited resources when they fall ill. Consequently, socially and economically vulnerable patients experience heightened financial distress due to cancer care expenses. This discrepancy is particularly noticeable among older patients.

Our findings indicate that older cancer patients living in rural areas (NRCMS users) experience more financial distress than their urban counterparts (URBMI and UEBMI users). This concurs with the findings of Su et al., who demonstrated that older patients with UEBMI insurance are less likely to face material financial hardship than those with NRCMS insurance.[42] In China, urban households primarily use URBMI and UEBMI. The UEBMI scheme includes a health savings account, offers the lowest coinsurance rates, and covers the widest range of health services. Neither of the other two schemes includes a health savings account. NRCMS, with the highest coinsurance rates, only covers inpatient services and has the lowest maximum copayment amount.[42] For vulnerable groups, such as the poor and elderly, the risk-sharing benefits and government subsidies provided by the NRCMS may be negated by rising medical costs.[43]

Our findings are evidence that health care providers should develop financial navigation programs for cancer patients of different age groups to help mitigate FT. Such programs could help patients prepare for high out-of-pocket treatment and medical costs and provide guidance on health insurance and accessing financial resources for medical and nonmedical costs.[44] However, in China, financial navigation is not commonly implemented in cancer care. This lack of financial support for cancer patients may have a significant impact on their overall well-being, as they may struggle to afford necessary medical expenses and treatments.

### *Limitations*

This study has three limitations worth noting. First, this study employed a cross-sectional design; therefore, no causal relationship between FT and variables could be concluded. The long-term effect of FT in different age groups cannot be observed. This could have limited the generalizability of our findings. Second, all questionnaires were self-completed by respondents. This could have introduced recall bias, potentially affecting the reliability of our findings. Last, our sample included only 60 patients aged under 40 years, which could introduce bias in our regression analysis. This might affect the generalizability of our findings.

## Conclusions

In general, regression analysis demonstrated that younger cancer patients reported lower FT than both middle-aged and older patients, without adjusting for the patients' background characteristics. The stratified analysis further showed that the associations between FT and demographic, socioeconomic, and clinical factors significantly vary across different age groups. This finding highlights that FT is a complex concept influenced by an individual's psychosocial characteristics, living environment, and health status. The need for targeted interventions to address the unique financial challenges faced by cancer patients at varying risk levels. We need to develop thorough strategies to reduce FT in cancer care at different age group. Implementing these strategies will help health care providers to ensure that all patients can access the necessary care without undue financial burden.

## Acknowledgement

We gratefully thank the patients who took part in this study and for generously sharing their time and thoughts with us.

## CRediT authorship contribution statement

LLW: Conceptualization; Project administration; Data curation, Formal analysis, Investigation; Writing – original draft; Writing – review & editing. RQS: Conceptualization, Data curation, Formal analysis, Writing – review & editing. LDT: Writing – review & editing. RHX: Conceptualization, Supervision, Data curation, Formal analysis, Writing – original draft; Writing – review & editing. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

## Ethics statement

The study protocol and informed consent were approved by the Human Research Ethics Committee of the Chinese University of Hong Kong (IRB No. SBRE-20-137). We confirm that all methods were performed in accordance with the relevant guidelines and regulations. Informed consent was obtained from all participants.

## Funding

This study received no external funding.

## 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.

## Data availability statement

The data that support the findings of this study are available from the corresponding author, Richard Huan Xu, upon reasonable request.

## Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apjon.2024.100552.

## References

1. Carrera PM, Kantarjian HM, Blinder VS. The financial burden and distress of patients with cancer: understanding and stepping-up action on the financial toxicity of cancer treatment. *CA Cancer J Clin*. 2018;68:153–165. https://doi.org/10.3322/caac.21443.
2. Guy GPJ, Ekwueme DU, Yabroff KR, et al. Economic burden of cancer survivorship among adults in the United States. *J Clin Oncol*. 2013;31:3749–3757. https://doi.org/10.1200/JCO.2013.49.1241.
3. Yabroff KR, Dowling EC, Guy GP, et al. Financial hardship associated with cancer in the United States: findings from a population-based sample of adult cancer survivors. *J Clin Oncol*. 2016;34:259–267. https://doi.org/10.1200/JCO.2015.62.0468.
4. Gordon LG, Merollini KMD, Lowe A, et al. A systematic review of financial toxicity among cancer survivors: we can't pay the Co-pay. *Patient*. 2017;10:295–309. https://doi.org/10.1007/s40271-016-0204-x.
5. Smith GL, Lopez-Olivo MA, Advani PG, et al. Financial burdens of cancer treatment: a systematic review of risk factors and outcomes. *J Natl Compr Canc Netw*. 2019;17:1184–1192. https://doi.org/10.6004/jnccn.2019.7305.

6. Xu B, Hu L, Cheng Q, et al. A systematic review of financial toxicity among cancer patients in China. *Asia Pac J Oncol Nurs*. 2022;9:100071. https://doi.org/10.1016/j.apjon.2022.04.010.
7. Ehsan AN, Wu CA, Minasian A, et al. Financial toxicity among patients with breast cancer worldwide: a systematic review and meta-analysis. *JAMA Netw Open*. 2023;6:e2255388. https://doi.org/10.1001/JAMANETWORKOPEN.2022.55388.
8. Azzani M, Atroosh WM, Anbazhagan D, et al. Describing financial toxicity among cancer patients in different income countries: a systematic review and meta-analysis. *Front Public Health*. 2023;11:1266533. https://doi.org/10.3389/FPUBH.2023.1266533/FULL.
9. Wheeler SB, Biddell CB, Manning ML, et al. Lessening the Impact of Financial Toxicity (LIFT): a protocol for a multi-site, single-arm trial examining the effect of financial navigation on financial toxicity in adult patients with cancer in rural and non-rural settings. *Trials*. 2022;23. https://doi.org/10.1186/s13063-022-06745-4.
10. Li L, Fu H. China's health care system reform: progress and prospects. *Int J Health Plann Manage*. 2017;32:240–253. https://doi.org/10.1002/HPM.2424.
11. Atella V, Brugiavini A, Pace N. The health care system reform in China: effects on out-of-pocket expenses and saving. *China Econo Rev*. 2015;34:182–195. https://doi.org/10.1016/J.CHIECO.2015.02.003.
12. Jia Y, Jiang W, Yang B, et al. Cost drivers and financial burden for cancer-affected families in China: a systematic review. *Curr Oncol*. 2023;30:7654–7671. https://doi.org/10.3390/CURRONCOL30080555/S1.
13. Mo M, Jia P, Zhu K, et al. Financial toxicity following surgical treatment for colorectal cancer: a cross-sectional study. *Support Care Cancer*. 2023;31. https://doi.org/10.1007/s00520-022-07572-8.
14. Jing J, Feng R, Zhang X, et al. Financial toxicity and its associated patient and cancer factors among women with breast cancer: a single-center analysis of low-middle income region in China. *Breast Cancer Res Treat*. 2020;181:435–443. https://doi.org/10.1007/s10549-020-05632-3.
15. Xu T, Xu L, Xi H, et al. Assessment of financial toxicity among patients with advanced lung cancer in Western China. *Front Public Health*. 2022;9. https://doi.org/10.3389/fpubh.2021.754199.
16. Qiu Z, Yao L, Jiang J. Financial toxicity assessment and associated factors analysis of patients with cancer in China. *Support Care Cancer*. 2023;31. https://doi.org/10.1007/s00520-023-07714-6.
17. Su M, Liu S, Liu L, et al. Heterogeneity of financial toxicity and associated risk factors for older cancer survivors in China. *iScience*. 2023;26. https://doi.org/10.1016/j.isci.2023.107768.
18. Yu H, Li H, Zuo T, et al. Financial toxicity and psychological distress in adults with cancer: a treatment-based analysis. *Asia Pac J Oncol Nurs*. 2022;9. https://doi.org/10.1016/j.apjon.2022.04.008.
19. Xu B, So WKW, Choi KC, et al. Financial toxicity and its risk factors among patients with cancer in China: a nationwide multisite study. *Asia Pac J Oncol Nurs*. 2024;11. https://doi.org/10.1016/j.apjon.2024.100443.
20. Corrigan KL, Fu S, Chen Y-S, et al. Financial toxicity impact on younger versus older adults with cancer in the setting of care delivery. *Cancer*. 2022;128:2455–2462. https://doi.org/10.1002/cncr.34220.
21. Lu AD, Zheng Z, Han X, et al. Medical financial hardship in survivors of adolescent and young adult cancer in the United States. *J Natl Cancer Inst*. 2021;113. https://doi.org/10.1093/jnci/djab013.
22. Fu W, Shi J, Zhang X, et al. Effects of cancer treatment on household impoverishment: a multicentre cross-sectional study in China. *BMJ Open*. 2021;11. https://doi.org/10.1136/bmjopen-2020-044322.
23. Sun C, Shi J, Fu W, et al. Catastrophic health expenditure and its determinants in households with lung cancer patients in China: a retrospective cohort study. *BMC Cancer*. 2021;21. https://doi.org/10.1186/s12885-021-09030-w.
24. Meeker CR, Wong Y-N, Egleston BL, et al. Distress and financial distress in adults with cancer: an age-based analysis. *J Natl Compr Cancer Netw*. 2017;15:1224–1233. https://doi.org/10.6004/jnccn.2017.0161.
25. Xu RH, Wang L, Zhou L, et al. Urban–rural differences in financial toxicity and its effect on cancer survivors' health-related quality of life and emotional status: a latent class analysis. *Support Care Cancer*. 2022;30. https://doi.org/10.1007/s00520-021-06762-0.
26. Song DH, Zhao FH, Zhang Y. Economic burden of cancer in China: causes and reflection. *Chin J Public Health*. 2023;39:137–140. https://doi.org/10.11847/zgggws1139301.
27. Jiang D, Zhang L, Liu W, et al. Trends in cancer mortality in China from 2004 to 2018: a nationwide longitudinal study. *Cancer Commun*. 2021;41. https://doi.org/10.1002/cac2.12195.
28. Souza JA, Yap BJ, Wroblewski K, et al. Measuring financial toxicity as a clinically relevant patient-reported outcome: the validation of the COmprehensive Score for financial Toxicity (COST). *Cancer*. 2017;123:476–484.
29. Honda K, Gyawali B, Ando M, et al. A prospective survey of comprehensive score for financial toxicity in Japanese cancer patients: report on a pilot study. *Ecancermedicalscience*. 2018;12:847. https://doi.org/10.3332/ecancer.2018.847.
30. Yu H-H, Yu Z-F, Li H, et al. The COmprehensive score for financial toxicity in China: validation and responsiveness. *J Pain Symptom Manage*. 2021. https://doi.org/10.1016/j.jpainsymman.2020.12.021. Published Online First.
31. Mols F, Tomalin B, Pearce A, et al. Financial toxicity and employment status in cancer survivors. A systematic literature review. *Support Care Cancer*. 2020;28. https://doi.org/10.1007/s00520-020-05719-z.
32. Zhao S, Zhang X, Dai W, et al. Effect of the catastrophic medical insurance on household catastrophic health expenditure: evidence from China. *Gac Sanit*. 2020;34. https://doi.org/10.1016/j.gaceta.2018.10.005.
33. Smith SK, Nicolla J, Zafar SY. Bridging the gap between financial distress and available resources for patients with cancer: a qualitative study. *J Oncol Pract*. 2014;10. https://doi.org/10.1200/JOP.2013.001342.
34. Su M, Yao N, Liu L, et al. Older cancer survivors living with financial hardship in China: a qualitative study of family perspectives. *Psycho Oncol*. 2022;31. https://doi.org/10.1002/pon.5854.
35. Chen S, Li L, Yang J, et al. The impact of long-term care insurance in China on beneficiaries and caregivers: a systematic review. *J Global Health Econo Policy*. 2021;1. https://doi.org/10.52872/001c.29559.
36. Liu L, Cao Y, Su M, et al. Financial toxicity among older cancer survivors in China: a qualitative study of oncology providers' perceptions and practices. *Support Care Cancer*. 2022;30:9433–9440. https://doi.org/10.1007/s00520-022-07303-z.
37. Yu Z. Homeownership attainment of adult children in urban China: parental attributes and financial support. *Hous Stud*. 2021;36. https://doi.org/10.1080/02673037.2020.1720617.
38. Knight T, Deal A, Muss H, et al. Financial distress among older versus younger adults with cancer. *J Clin Oncol*. 2016;34. https://doi.org/10.1200/JCO.2016.34.15_suppl.e1826.
39. Giri S, Clark D, Al-Obaidi M, et al. Financial distress among older adults with cancer. *JCO Oncol Pract*. 2021;17. https://doi.org/10.1200/op.20.00601.
40. Arastu A, Patel A, Mohile SG, et al. Assessment of financial toxicity among older adults with advanced cancer. *JAMA Netw Open*. 2020;3:e2025810. https://doi.org/10.1001/jamanetworkopen.2020.25810.
41. Heinesen E, Imai S, Maruyama S. Employment, job skills and occupational mobility of cancer survivors. *J Health Econ*. 2018;58:151–175. https://doi.org/10.1016/j.jhealeco.2018.01.006.
42. Su M, Lao J, Zhang N, et al. Financial hardship in Chinese cancer survivors. *Cancer*. 2020;126:3312–3321. https://doi.org/10.1002/cncr.32943.
43. Yang M. Demand for social health insurance: evidence from the Chinese New rural cooperative medical scheme. *China Econo Rev*. 2018;52:126–135. https://doi.org/10.1016/j.chieco.2018.06.004.
44. Doherty MJ, Thom B, Gany F. Evidence of the feasibility and preliminary efficacy of oncology financial navigation: a scoping review. *Cancer Epidemiol Biomarkers Prev*. 2021;30:1778–1784. https://doi.org/10.1158/1055-9965.EPI-20-1853.