Cost drivers and financial burden for cancer-affected families in China: a systematic review

Yufei Jia  
Duke Kunshan University

Weixi Jiang  
Fudan University

Bolu Yang  
Duke Kunshan University

Shenglan Tang  
Duke University

Qian Long (qian.long@dukekunshan.edu.cn)  
Duke Kunshan University

Research Article

Keywords: cancer, cost, financial burden, coping strategies

Posted Date: April 27th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2814960/v1

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Abstract

Background: Cancer has been the leading cause of death in China and imposes heavy burdens on individuals and the health system. China’s cancer control plan includes efforts to mitigate financial hardship for the affected households in the context of ongoing health system reform. However, evidence is limited about how the affected families afford cancer care.

Methods: This systematic review is to map medical, non-medical, and indirect costs incurred by cancer care, the financial burden for patients, and their economic coping strategies from 2009 onwards. We included original quantitative studies conducted in mainland China that reported out-of-pocket payment for cancer care and patients’ coping strategies in English or Chinese. We searched PubMed, Embase, Ovid, Web of Science, Cochrane and two Chinese databases (CNKI and WanFang Data) from January 1st 2009 to 10th August 2022. We introduced ten quality criteria for quality assessment of the included studies according to the standards for reporting observational studies. We reported components of costs and coping strategies narratively and presented costs as a percentage of household income.

Results: Annual mean medical costs (including inpatient and outpatient costs and fees for self-purchasing drugs) ranged from US$7421 to US$10297 (an unweighted average of US$8794) per patient. In a study that investigated medical costs for five years, inpatient costs accounted for 51.6% of total medical costs, followed by self-purchasing drugs (43.9%). The estimation of non-medical and indirect costs varied considerably. Annual medical costs as a percentage of annual household income ranged from 36.0% to 63.1% with a meta-proportion of 51.0%. The common coping strategies included borrowing money, reduction of household expenses and expenses from basic health services.

Conclusions: Costs of inpatient care and self-purchasing drugs are major drivers of medical costs for cancer care, and many affected households shoulder a very heavy financial burden. This will require strengthening stewardship for cancer control and multi-sector cooperation to mitigate the risk of financial hardship.

Introduction

In 2020, cancer was the leading cause of death in China with a total of 3 million deaths. This accounted for 30% of all cancer deaths in the world.1 With the demographic and epidemiological transition in China, the continued increase of new cancer cases not only imposes burdens on individuals and the health system, but also leads to productivity losses for society due to premature mortality from cancer.2–4 It is estimated that the total cost of lost productivity attributable to cancer-related premature death in China in 2012 was US$28 billion, corresponding to 0.34% of the total gross domestic product (GDP).3

In China, cancer survival has remarkably increased over the past two decades; however, geographic, social, and economic inequalities in cancer outcomes remain.2,5,6 The socially and economically disadvantaged population is more likely to delay access to cancer care and subsequently have inadequate treatment, which is often associated with poorer cancer prognosis.2,6 The most common hindrance to cancer treatment is financial hardship, which includes expensive medical costs, high non-medical costs for access to care, and loss of income. Families with cancer patients often experience heavy financial burdens caused by cancer care, moreover, some families were driven into poverty.7

The international community has acknowledged that achieving universal health coverage (UHC), equal access to high quality health care without suffering from financial hardship, is essential to move towards other health-related Sustainable Development Goals (SDGs) including a one-third reduction in premature mortality from non-communicable diseases by 2030.2 In 2009, China launched an in-depth healthcare system reform with a rapid scaling-up of essential health insurance coverage (including Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI) and New Cooperative Medical Scheme (NCMS) for rural residents), which aimed to protect patients with severe diseases from financial risks.8 When the health insurance schemes were initiated, they primarily provided a relatively high reimbursement proportion for inpatient care but very limited coverage of outpatient care. In 2013, eight cancers were covered by the Catastrophic Insurance for rural residents indicating no less than 70% of reimbursement for inpatient care.9 In 2015, the Chinese government launched the first round of negotiations on drug procurement including a couple of first-line anti-cancer drugs.10 Since then, more drugs for cancer treatment were covered by essential health insurance schemes. By 2020, a total of 52 drugs for several common cancers in China were included.11,12 In addition, the urban and
rural resident health insurance schemes have increased the coverage of outpatient care for expensive chronic diseases (including cancer) in 2019.\textsuperscript{13}

Despite the efforts China has made to provide financial protection for cancer patients, evidence is limited about how the affected families afford cancer care. We conducted a systematic review of medical costs, direct non-medical costs, and indirect costs incurred by cancer care as well as the financial burden placed on families with cancer patients and their economic coping strategies. Our aim was to provide evidence for the scale-up of social protection strategies to mitigate risks of financial hardship caused by cancer.

**Methods**

**Eligibility criteria and search strategy**

The protocol of systematic review was registered in PROSPERO (registration number: CRD42021273989). In this systematic review, we included original quantitative studies conducted in mainland China that reported direct medical costs, non-medical costs, indirect costs for cancer care paid out-of-pocket, and the patients’ coping strategies. We screened articles in English and Chinese and only included those published between January 1st January 2009 and 10th August 2022. Quantitative data from longitudinal and cross-sectional studies and baseline data of experimental studies were eligible for inclusion. We used data from 2009 onwards for analysis in correspondence to the new round of health system reform in China. Studies that used secondary data derived from other published articles, did not explicitly report on the methods used for data collection or data analysis, or did not report on patient costs were excluded.

We searched the following databases: PubMed, Embase, Ovid, Web of Science, Cochrane and two Chinese databases (CNKI and WanFang Data) with a combination of key search terms “cancer, tumor, carcinoma, oncology; cost, expenditure, payment, spending, financial, burden; insurance, social protection; China, Chinese.” We presented the search strategy for each database in eTable 1. In addition to the database search, we screened the reference lists of included studies to identify relevant studies. We used Covidence to manage all citations and removed duplicates. Two reviewers independently screened titles and abstracts and retrieved the full texts for evaluation if a citation was considered relevant or uncertain for inclusion or exclusion due to insufficient information obtained from the title and abstract. A third reviewer was involved to resolve discrepancies and uncertainties at the selection stage.

**Data extraction and quality assessment of included studies**

We developed a data extraction form including the following information: study settings, type of cancer, study design, study period, data source and methods of data collection as well as the outcomes (including components of costs, financial burden, and coping strategies). We extracted data on costs by medical costs (with stratification of inpatient and outpatient costs), non-medical costs, and indirect costs according to available data from the included studies. When possible, we also extracted cost data by patients’ demographic (e.g., age, sex), socioeconomic status (e.g., type of health insurance), and clinical stage of cancer. Additionally, we extracted data on the percentage of households with a cancer patient facing catastrophic expenditure, defined by the study authors, as well as coping strategies where available. One reviewer extracted the data, and another reviewer checked it. A third reviewer assessed and reached a consensus on data extraction. If the information was unclear or lacking details, we contacted the authors for clarification and additional information.

According to the standards for reporting observational studies (STROBE, NEWCASTLE, and Circum Network's Quality Criteria for Survey Research), we introduced ten quality criteria to assess methodological quality and transparent reporting of quantitative studies (eTable 2) which were included in this review\textsuperscript{14–16} Each criterion was scored with one point if the assessment was satisfactory. The score for each study could be ranging from 0 to 10. We valued the overall quality of a study as ‘low’, ‘middle’ or ‘high’ if the score was lower than, equal to or higher than the median score across all included studies, respectively. One reviewer conducted the quality assessment of all included studies, and a second reviewer checked and discussed with a third reviewer if there was any discrepancy.

**Data analysis**
Given the large heterogeneity across studies, we reported the distribution by components of costs during the study periods defined in each study. We recorded the range of means across studies and calculated the unweighted average of means (with standard deviation) and the median of mean costs (with an interquartile range of means) for all cost components. We summarized the sub-group costs by age, sex, type of health insurance, and stages of cancer when data on cost components were available. If one study reported data for several different types of cancers, each type of cancer was involved in the analysis as an individual observation. All data on costs were converted from the Chinese Yuan into the US dollar based on the exchange rate in 2020.\(^{17}\) We adjusted for inflation using the Consumer Price Index (CPI) for healthcare on medical costs and the general CPI on non-medical costs, indirect costs, and annual household income.\(^{18}\)

We also presented the range of percentages accounting for different cost components in the costs breakdown analysis. Furthermore, we calculated the annual out-of-pocket payment for cancer care as a percentage of annual household income and conducted a meta-analysis of proportions using STATA 16.\(^{19}\) In addition, we presented the range of percentages of catastrophic health expenditure and coping strategies reported in the studies narratively.

**Results**

**Study identification and main characteristics of the studies**

eFigure 1 presents the search, screening, and study inclusion and exclusion profile. After screening titles and abstracts, we retrieved 1269 studies for full-text assessment. Of these studies, we excluded 1231 studies largely due to no relevant data, unclear data sources, and ambiguous cost components reported in the study. A total of 38 studies (23 in English and 15 in Chinese) were included.

We presented the main characteristics of the included studies in Table 1. All studies were cross-sectional studies and data for the studies were obtained from patient surveys (or surveys in combination with data extraction from hospital records or health insurance records) (n = 25), hospital-based payment records (n = 4), and health insurance records (n = 9). 25 studies reported annual mean costs of cancer treatment,\(^{20–44}\) one study reported the average monthly medical cost,\(^{45}\) one study reported the average cost of cancer care for five years,\(^ {46}\) and three studies reported the costs during the illness without specifying the course of treatment.\(^ {47–49}\)

Four studies only reported the median of the costs which were not included in the data synthesis.\(^ {50–53}\) In addition, two studies only reported coping strategies\(^ {54,55}\) and two reported the proportion of catastrophic expenditure without reporting cost data.\(^ {56,57}\)

According to the quality assessment for all included studies, 10 studies\(^ {26,37–41,47,51,55,56}\) were assessed as high quality, 10 studies\(^ {27–29,36,42,43,46,52–54}\) at the middle level and 18 studies\(^ {21,23,24,30–35,44,45,48,49,57}\) as low quality.

**Distribution of cost components**

**Medical costs**

This section reported total medical costs, inpatient and outpatient costs across studies (Table 1). 15 studies (including 21 observations, more than one type of cancer in a study) reported annual medical costs for cancer treatment (eTable 3).\(^ {20,22,27–29,31,32,34,36–42}\) Of these, mean medical costs including inpatient and outpatient costs across 12 studies (18 observations) ranged from US$1802 to US$14684 with an unweighted average of US$4530 and a median of US$3947.\(^ {22,27–29,31,32,34,36,38–40,42}\)

The other three studies included medical costs of inpatient and outpatient care as well as self-purchasing drugs from pharmacies, and the average costs ranged from US$7421 to US$10297 with an unweighted average of US$8794.\(^ {22,36,42,43,46,52–54}\)

Mean annual inpatient costs from 12 studies (including 33 observations) ranged from US$1369 to US$8647 with an unweighted average of US$3146, and a median of US$2843 (eTable 3).\(^ {21–26,30,33–35,40,43}\) Average outpatient costs in a year from 5 studies (including 5 observations) varied from US$115 to US$865 with an unweighted average of US$626, and a median of US$772.\(^ {22,25,30,34,40}\)

Of the two studies that reported both inpatient and outpatient costs per patient incurred within a year, the inpatient costs accounted for 82.0% and 94.3% of the total medical cost, respectively.\(^ {22,40}\)

Four studies from a multi-center patient survey reported medical costs (both inpatient and outpatient costs) for 12 months (2 months before and 10 months after diagnosis) stratified by age, sex, stages of cancer, and type of health insurance for different...
types of cancer (Table 2). The average medical costs for stomach cancer and colorectal cancer were higher than costs for breast cancer and liver cancer (unweighted average US$4771, median US$4752). Patients over 65 years old often spent less on cancer care, while there was no significant difference in annual medical costs by sex. In terms of the stages of cancer, patients at stage IV often spent more on cancer care than patients at stage I. In a stratification of health insurance type, cancer patients with UEBMI paid the least medical cost out-of-pocket within a year, followed by patients with URRBMI, and patients with NCMS and commercial health insurance paid the most. In these studies, few patients did not have any type of health insurance, and the average annual medical costs ranged from US$6900 to US$8702 with an unweighted average of US$7857 and a median of US$7913. In addition, one patient survey reported inpatient and outpatient costs as well as costs of self-purchasing drugs from the pharmacies within a year, and the mean cost among patients covered by UEBMI was US$7984 compared to the average cost of US$9441 among patients covered by URBMI. Another study based on health insurance records reported average annual out-of-pocket payments by patients with UEBMI and URBMI were US$1741 and US$2507, respectively, which was lower than data obtained from patient surveys.
### Table 2
Annual medical costs by subgroups from a multi-center patient survey (four studies), mean US$ (n)

<table>
<thead>
<tr>
<th>Study</th>
<th>Huang, 2017</th>
<th>Liao, 2018</th>
<th>Lei, 2020</th>
<th>Zhang, 2020</th>
<th>Unweighted average cost [SD, range]</th>
<th>Median [IQR]</th>
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</thead>
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<tr>
<td><strong>Cancer</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5397.75</td>
<td>4105.94</td>
<td>4056.78</td>
<td>5524.95</td>
<td>4771.35 [691.68]</td>
<td>4751.84</td>
</tr>
<tr>
<td>(2356)</td>
<td>(2746)</td>
<td>(2223)</td>
<td>(2401)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Male</td>
<td>5269.93</td>
<td>–</td>
<td>4098.26</td>
<td>5537.24</td>
<td>4968.48 [624.94]</td>
<td>5269.93</td>
</tr>
<tr>
<td>(1345)</td>
<td>(1760)</td>
<td>(1677)</td>
<td></td>
<td></td>
<td></td>
<td>[4684.10, 5403.59]</td>
</tr>
<tr>
<td>Female</td>
<td>5567.83</td>
<td>–</td>
<td>3896.27</td>
<td>5496.70</td>
<td>4986.93 [771.76]</td>
<td>5496.70</td>
</tr>
<tr>
<td>(1011)</td>
<td>(463)</td>
<td>(724)</td>
<td></td>
<td></td>
<td></td>
<td>[4696.48, 5532.26]</td>
</tr>
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<td><strong>Age</strong></td>
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<tr>
<td>&lt; 45</td>
<td>6091.26</td>
<td>4392.20</td>
<td>4968.24</td>
<td>5506.52</td>
<td>5239.55 [630.14]</td>
<td>5237.38</td>
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<tr>
<td>(361)</td>
<td>(860)</td>
<td>(362)</td>
<td>(310)</td>
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<td></td>
<td>[4824.23, 5652.71]</td>
</tr>
<tr>
<td>45–54</td>
<td>5697.24</td>
<td>4107.16</td>
<td>4319.19</td>
<td>5891.07</td>
<td>5003.67 [796.99]</td>
<td>5008.22</td>
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<tr>
<td>(542)</td>
<td>(1044)</td>
<td>(633)</td>
<td>(513)</td>
<td></td>
<td></td>
<td>[4266.19, 5745.70]</td>
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<tr>
<td>55–64</td>
<td>5352.88</td>
<td>3873.73</td>
<td>3849.41</td>
<td>5534.78</td>
<td>4652.70 [793.79]</td>
<td>4613.31</td>
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<tr>
<td>(787)</td>
<td>(654)</td>
<td>(745)</td>
<td>(902)</td>
<td></td>
<td></td>
<td>[3867.65, 5398.36]</td>
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<tr>
<td>&gt;=65</td>
<td>4830.85</td>
<td>3604.67</td>
<td>3328.58</td>
<td>5239.92</td>
<td>4251.01 [803.55]</td>
<td>4217.76</td>
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<tr>
<td>(666)</td>
<td>(188)</td>
<td>(483)</td>
<td>(676)</td>
<td></td>
<td></td>
<td>[3535.65, 4933.12]</td>
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<td><strong>Clinical stage</strong></td>
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<tr>
<td>I</td>
<td>4438.44</td>
<td>3566.59</td>
<td>3777.62</td>
<td>5414.38</td>
<td>4299.26 [719.68]</td>
<td>4108.03</td>
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<tr>
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<td>(546)</td>
<td>(299)</td>
<td>(420)</td>
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</tr>
<tr>
<td>II</td>
<td>5306.82</td>
<td>4018.71</td>
<td>3948.31</td>
<td>5333.29</td>
<td>4651.78 [668.80]</td>
<td>4662.76</td>
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<tr>
<td>(630)</td>
<td>(1236)</td>
<td>(493)</td>
<td>(347)</td>
<td></td>
<td></td>
<td>[4001.11, 5313.44]</td>
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<tr>
<td>III</td>
<td>5490.87</td>
<td>4508.91</td>
<td>4034.45</td>
<td>5760.84</td>
<td>4948.77 [704.06]</td>
<td>4999.89</td>
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<tr>
<td>(815)</td>
<td>(603)</td>
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<td>(661)</td>
<td></td>
<td></td>
<td>[4390.30, 5558.36]</td>
</tr>
<tr>
<td>IV</td>
<td>5921.37</td>
<td>5227.64</td>
<td>4003.15</td>
<td>5430.35</td>
<td>5145.63 [706.19]</td>
<td>5328.99</td>
</tr>
</tbody>
</table>

UEBMI: urban employee basic medical insurance.

URBMI: urban residence basic medical insurance.

NCMS: new rural cooperative medical scheme.
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Cancer</td>
<td>colorectal cancer</td>
<td>breast cancer</td>
<td>liver cancer</td>
<td>stomach cancer</td>
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<tr>
<td>Total</td>
<td>5397.75</td>
<td>4105.94</td>
<td>4056.78</td>
<td>5524.95</td>
<td>4771.35 [691.68]</td>
<td>4751.84 [4093.65, 5429.55]</td>
</tr>
<tr>
<td></td>
<td>(2356)</td>
<td>(2746)</td>
<td>(2223)</td>
<td>(2401)</td>
<td>[4056.78, 5524.95]</td>
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<tr>
<td>UEBMI</td>
<td>4333.35</td>
<td>3462.16</td>
<td>3379.42</td>
<td>4298.82</td>
<td>3868.44 [448.77]</td>
<td>3880.49</td>
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<td></td>
<td>(916)</td>
<td>(1052)</td>
<td>(852)</td>
<td>(803)</td>
<td>[3379.42, 4333.35]</td>
<td>[3441.47, 4307.46]</td>
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<tr>
<td>URBMI</td>
<td>4909.42</td>
<td>3193.10</td>
<td>3747.32</td>
<td>4833.26</td>
<td>4170.77 [727.95]</td>
<td>4290.29</td>
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<td>(518)</td>
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<td>(404)</td>
<td>[3193.10, 4909.42]</td>
<td>[3608.76, 4852.30]</td>
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<td>NCMS</td>
<td>6504.81</td>
<td>5001.58</td>
<td>4713.41</td>
<td>6545.91</td>
<td>5691.43 [840.26]</td>
<td>5753.19</td>
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<td></td>
<td>(897)</td>
<td>(1027)</td>
<td>(890)</td>
<td>(1136)</td>
<td>[4713.41, 6545.91]</td>
<td>[4929.53, 6515.09]</td>
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<td>Commercial insurance</td>
<td>7938.30</td>
<td>5250.98</td>
<td>3786.80</td>
<td>7328.52</td>
<td>6076.15 [1655.15]</td>
<td>6289.75</td>
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<td>(22)</td>
<td>(46)</td>
<td>(19)</td>
<td>(14)</td>
<td>[3786.80, 7938.30]</td>
<td>[4884.93, 7480.96]</td>
</tr>
<tr>
<td>No health insurance</td>
<td>8358.03</td>
<td>6899.74</td>
<td>7468.31</td>
<td>8702.08</td>
<td>7857.04 [712.85]</td>
<td>7913.17</td>
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<tr>
<td></td>
<td>(49)</td>
<td>(71)</td>
<td>(40)</td>
<td>(30)</td>
<td>[6899.74, 8702.08]</td>
<td>[7326.17, 8444.04]</td>
</tr>
</tbody>
</table>

UBEBI: urban employee basic medical insurance.

URBMI: urban residence basic medical insurance.

NCMS: new rural cooperative medical scheme.

In addition, one study reported the medical costs for five years among 195 surviving lung cancer patients was US$36034 on average. Of which, inpatient costs (US$18590) accounted for 51.6% of total medical costs, followed by purchasing drugs from pharmacies (43.9%, US$15812) and outpatient costs (4.5%, US$1632).

**Table 3. Annual medical cost as a percentage of annual household income from nine studies, %**
<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Cancer patients (n)</th>
<th>Year</th>
<th>Data source</th>
<th>Definition of medical cost in the study</th>
<th>Annual Medical Costs (US$)</th>
<th>Annual household income (US$)</th>
<th>Annual OOP medical costs/household income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huang, 2012</td>
<td>lung cancer</td>
<td>402</td>
<td>2010-2011</td>
<td>survey</td>
<td>inpatient, outpatient, and fees for purchasing drugs from pharmacies</td>
<td>7420.85</td>
<td>13550.73</td>
<td>54.8%</td>
</tr>
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<td>Huang, 2017</td>
<td>colorectal cancer</td>
<td>2356</td>
<td>2012-2014</td>
<td>survey</td>
<td>inpatient, outpatient</td>
<td>5397.75</td>
<td>10013.99</td>
<td>53.9%</td>
</tr>
<tr>
<td>Liao, 2018</td>
<td>breast cancer</td>
<td>2746</td>
<td>2012-2014</td>
<td>survey</td>
<td>inpatient, outpatient</td>
<td>4105.94</td>
<td>10990.09</td>
<td>37.4%</td>
</tr>
<tr>
<td>Lei, 2020</td>
<td>liver cancer</td>
<td>2223</td>
<td>2012-2014</td>
<td>survey</td>
<td>inpatient, outpatient</td>
<td>4056.78</td>
<td>11259.70</td>
<td>36.0%</td>
</tr>
<tr>
<td>Zhang, 2020</td>
<td>stomach cancer</td>
<td>2401</td>
<td>2012-2014</td>
<td>survey</td>
<td>inpatient, outpatient</td>
<td>5524.95</td>
<td>9481.50</td>
<td>58.3%</td>
</tr>
<tr>
<td>Sun, 2021</td>
<td>lung cancer</td>
<td>2565</td>
<td>2015-2016</td>
<td>survey</td>
<td>inpatient, outpatient, and fees for purchasing drugs from pharmacies</td>
<td>8663.51</td>
<td>13725.00</td>
<td>63.1%</td>
</tr>
<tr>
<td>Lin, 2017</td>
<td>multi-cancer</td>
<td>252</td>
<td>2015-2016</td>
<td>Survey and basic health insurance database</td>
<td>Medical costs related to cancer treatment</td>
<td>2410.07</td>
<td>5265.00</td>
<td>45.8%</td>
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<tr>
<td>Huang, 2021</td>
<td>cancer</td>
<td>332</td>
<td>2015-2016</td>
<td>survey</td>
<td>Medical costs related to cancer treatment</td>
<td>10431.25</td>
<td>16893.94</td>
<td>61.7%</td>
</tr>
<tr>
<td>Chen, 2020</td>
<td>esophageal cancer</td>
<td>184</td>
<td>2019</td>
<td>survey</td>
<td>Inpatient, outpatient</td>
<td>4460.12</td>
<td>3454.45</td>
<td>129.1%</td>
</tr>
</tbody>
</table>

Random Pooled ES (95% CI) of the proportion of the annual medical cost to annual household income from eight studies: 51% [44%, 59%]

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Cancer patients (n)</th>
<th>Year</th>
<th>Data source</th>
<th>Definition of medical cost in the study</th>
<th>Annual Medical Costs (US$)</th>
<th>Annual household income (US$)</th>
<th>Annual OOP medical costs/household income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huang, 2021</td>
<td>cancer</td>
<td>332</td>
<td>2015-2016</td>
<td>survey</td>
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<td>Inpatient, outpatient</td>
<td>4460.12</td>
<td>3454.45</td>
<td>129.1%</td>
</tr>
</tbody>
</table>

a In these studies, costs incurred during 2 months before and 10 months after diagnosis.

b This study was not included in the analysis of Meta-proportion.

Non-medical costs

Items for non-medical costs varied across studies but largely included costs on transportation and lodging for both patients and family members as well as fees for extra nutritional products for patients and hiring care workers (eTable 4). The average annual non-medical costs from eight studies (8 observations) ranged from US$688 to US$4978 with an unweighted average of US$1486.20,25,27,29,36–39

Direct costs

Across seven studies that reported both annual medical and non-medical costs, the average direct costs for cancer care within a year varied from US$4903 to US$12399 (eTable 5).20,27,29,36–39 Of which, the proportion of medical costs accounting for total direct costs...
ranged from 59.9–88.1%. One study reported medical costs and non-medical costs for five years of the treatment, and the non-medical costs accounted for 6% of the total direct cost (US$38313).46

Indirect costs

The estimation of indirect costs varied across seven studies without a clear definition in one study (eTable 6).20,26,39,44,46,47,49 We estimated the percentage of the indirect cost out of the overall costs (total of direct and indirect costs) from four studies based on available data.20,39,46,49 One study estimated annual indirect costs including loss of income for both lung cancer patients and caregivers and financial loss due to seeking non-medical support for the illness, which was US$9978 on average accounting for 44.6% of annual overall costs.20 Another study only accounted for time loss of both esophageal cancer patients and caregivers caused by cancer treatment and estimated mean US$1086 annual indirect costs, around 17.4% of annual overall costs.39 One study investigated parents’ time loss due to taking care of children with retinoblastoma (n = 50) during a treatment lasting 23–58 months, which accounted for 32.6% of overall costs.49 The last study estimated time loss for both lung cancer patients and caregivers due to the hospital visits within five years of the treatment and reported the lowest indirect costs, on average US$959.46

Financial burden on households with cancer patient and the coping strategies

We calculated the annual medical costs as a percentage of annual household income across the eight studies where data were available (Table 3).20,27,28,29,36,38,41,42 This proportion ranged from 36.0–63.1% with a meta-proportion of 51.0%. Across five studies that reported both annual medical and non-medical costs, annual direct costs as a percentage of annual household income ranged from 43.6–91.5% with a meta-proportion of 64.0% (eTable 7).20,27,29,36,38 One study investigated the financial burden of patients with esophageal cancer (n = 184) from a cancer specialty hospital in central China and found the average annual medical cost was 1.3 times a patients’ annual household income.39

Nine studies reported the rates of catastrophic health expenditure (CHE) incurred by cancer care (Table 4).26,37,41–43,45,50,56,57 Five studies defined CHE as an annual medical cost accounting for more than 40% of a household's non-food expenditures.37,41–43,57 Of the five studies, one study that used nationally representative data among adults over 45 years old obtained from the 2011 and 2015 China Health and Retirement Longitudinal Studies estimated the rates of CHE being 25.1% in 2011 and 27.2% in 2015 for all types of cancer patients; however, this study found only half of the participants had received cancer treatment which may underestimate the CHE rates given those who gave up treatment due to financial difficulties. This study also highlighted patients’ socioeconomic and urban-rural status associated with the utilization of cancer care. The other four studies recruited cancer patients who accepted the treatment and reported rates of CHE ranging from 43.4–78.1%. In addition, one study estimated the financial burden placed on cancer patients caused by inpatient care in a year.26 In this study, 20.6% of cancer patients paid for inpatient treatment which was more than 40% of annual household income. Two studies defined CHE as annual direct costs (including both medical and non-medical costs) over 40% of annual households’ non-food expenditure or income, in which the CHE rates ranged from 49.6–72.7%.50,56 One study investigated the CHE rate during the last three months of life among advanced cancer patients and found more than 90% of households (94.3% of urban households and 96.1% of rural households) spent over 40% of their monthly income on care.45
### Table 4
Catastrophic health expenditure (CHE) incurred by cancer care from nine studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Cancer patients (n)</th>
<th>Year</th>
<th>Location</th>
<th>Definition of CHE</th>
<th>CHE rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2015: 27.15%</td>
</tr>
<tr>
<td>Sun,2021</td>
<td>breast cancer</td>
<td>639</td>
<td>2015–2016</td>
<td>multi-center</td>
<td></td>
<td>66.82%</td>
</tr>
<tr>
<td>Sun,2021 a</td>
<td>lung cancer</td>
<td>2565</td>
<td>2015–2016</td>
<td>multi-center</td>
<td></td>
<td>78.1%</td>
</tr>
<tr>
<td>Huang,2021 a</td>
<td>cancer</td>
<td>332</td>
<td>2015–2016</td>
<td>Guangxi</td>
<td></td>
<td>61.14%</td>
</tr>
<tr>
<td>Sui,2020</td>
<td>pediatric leukemia</td>
<td>242</td>
<td>2018</td>
<td>Heilongjiang</td>
<td></td>
<td>43.4%</td>
</tr>
<tr>
<td>Che,2016</td>
<td>liver cancer</td>
<td>131</td>
<td>2013</td>
<td>Yunnan</td>
<td>Annual direct cost (including medical cost and non-medical cost) more than 40% annual households' income</td>
<td>49.6%</td>
</tr>
<tr>
<td>Chen,2018</td>
<td>lung cancer</td>
<td>227</td>
<td>2016</td>
<td>Shanghai</td>
<td></td>
<td>72.70%</td>
</tr>
<tr>
<td>Leng,2019</td>
<td>cancer patients at the end-of-life</td>
<td>792</td>
<td>2013–2016</td>
<td>multi-center</td>
<td>Monthly direct cost (including medical cost and non-medical cost) more than 40% monthly households' income</td>
<td>Rural: 96.1% Urban: 94.3%</td>
</tr>
<tr>
<td>Zhao,2016</td>
<td>cancer</td>
<td>318</td>
<td>2014</td>
<td>Anhui</td>
<td>Annual inpatient cost more than 40% of annual household income</td>
<td>20.6%</td>
</tr>
</tbody>
</table>

a In these studies, costs incurred during 2 months before and 10 months after diagnosis.

Zhao, 2022: Data from a population-based survey, only approximately half of the cancer patients utilized treatment.

Chen,2018: Cost-income ratio was reported by the participants.

Six studies investigated coping strategies when households with cancer patients shouldered expensive expenditures on cancer care (Table 5). All studies reported borrowing money from relatives and friends or a loan. In two more recent studies, the reduction of household expenses (66.2%) or the reduction of expenses on basic health services (41.2%) were common strategies for addressing challenges caused by cancer care. One study recruited parents with children diagnosed with leukemia and found the most common strategy was borrowing money from relatives and friends (97.9%), followed by charity assistance (54.6%) and government subsidy (16.1%).
### Table 5
Coping with costs incurred by cancer care from six studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Cancer patients</th>
<th>Year</th>
<th>Location</th>
<th>Coping strategy</th>
</tr>
</thead>
</table>
| Sui, 2020   | pediatric leukemia               | 242             | 2018       | Heilongjiang      | Support from relatives and friends: 97.93%  
                                              |                  |                |                        | Government subsidy: 16.12%  
                                              |                  |                |                        | Charity assistance: 54.55%  |
| Chen, 2020  | esophageal cancer                | 184             | 2019       | Anhui             | Borrowed money from relatives and friends: 45.10% |
| Xiao, 2022  | advanced gastroesophageal        | 66              | 2019       | multi-country     | Financial support from caregivers: 62.1%  |
|             | adenocarcinoma                   |                 |            |                   |                                              |
| Leng, 2019  | cancer patients at the end-of-life | 792            | 2013–2016  | multi-center      | Borrowed money from relatives and friends: 32.10% |
| Wang, 2022  | colorectal cancer                | 4428            | 2020–2021  | Multi-center      | -Borrowed from relatives and friends: 25.5%  
                                              |                  |                |                        | -Borrowed from financial institutions: 1.7%  
                                              |                  |                |                        | -Reduce spending on leisure activities: 41.15%  
                                              |                  |                |                        | -Reduce household expenses: 66.2%  
                                              |                  |                |                        | -Selling properties: 4.7%  |
| Liu, 2022   | breast cancer                    | 627             | 2021       | National          | -Borrowed money or acquired a loan due to illness: 21.21%  
                                              |                  |                |                        | -Reduced spending on leisure activities: 41.15%  
                                              |                  |                |                        | -Considered quitting treatment: 11.64%  
                                              |                  |                |                        | -Delayed treatment for more than seven days: 5.42%  
                                              |                  |                |                        | -Failed to take medicine as instructed: 6.7%  
                                              |                  |                |                        | -Failed to attend medical visits as instructed: 3.35%  
                                              |                  |                |                        | -Reduced spending on basic health services: 41.15%  
                                              |                  |                |                        | -At least one coping strategy: 48.01%  |

### Discussion
This systematic review mapped the medical, non-medical and indirect costs incurred by cancer care in China from 2009 onwards. This review demonstrated that costs of inpatient care and patients self-purchasing drugs were major components of medical costs. Despite a vast majority of patients being enrolled in different types of health insurance schemes, the out-of-pocket payment for cancer care remained high. Given non-medical costs and indirect costs incurred by cancer care, the financial burden placed on the affected households was often very heavy, and many families faced catastrophic health expenditures.

### Interpretations
Over the past two decades, cancer survival has remarkably increased in China suggesting improved accessibility and availability in the quality of cancer care. Similar to other low- and middle-income countries, however, the financial risk protection for access to cancer care remains insufficient. In this review, inpatient care was a major component of medical costs. Despite the substantial government investment that almost achieved universal health insurance coverage, the deductible and co-payment, particularly at specialty hospitals, are often high. Moreover, many new cancer diagnosis technologies, innovative therapies, and health products are costly yet are not covered by essential health insurance schemes. Over the past decade, the Chinese government continues to increase funding for URBMI and rural NCMS and most of provinces have integrated the two schemes into one Urban and Rural Residents Basic Medical Insurance for expanding the risk pools; however, the benefit packages of these two schemes are still more constrained compared to UEBMI coverage. In alignment with the ongoing health system reform, the government encourages cooperation between public and private health sectors including pilots of commercial health insurance development serving as a supplementary health insurance schemes of the basic health insurance schemes. It is not surprising to find in this review that patients with UEBMI paid the least medical cost out-of-pocket compared to patients with other types of health insurance.

Patients self-purchasing drugs was another primary driver of medical cost and was often not reimbursable by health insurance schemes. One study identified that self-purchasing drugs accounted for more than 40% of medical costs within five years. Additionally, the annual medical costs, in several studies which counted patients purchasing drugs themselves, were also significantly higher than the average annual medical cost in the studies that only investigated costs on inpatient and outpatient care. Nevertheless, these studies did not describe the type of drugs purchased by patients themselves nor interpretations on motivations or reasons for this patient's behavior. Other cancer studies in China indicated unaffordable or unavailable patented anti-cancer medicines or the application of traditional Chinese medicine as a supplementary approach, which may partially explain the costs incurred by patients purchasing drugs themselves.

In this review, although the annual medical costs varied by type of cancer, the costs at late-stage cancer were often higher than the costs at early-stage. In 2005, China initiated the cancer screening and early detection program (including female breast and cervical cancers, liver, stomach, esophageal, and nasopharynx cancers) and gradually expanded to all provinces in mainland China by 2015. The implementation and the effects of the cancer screening program between urban and rural areas and across regions in China should be further evaluated. Awareness of and willingness to having active medical examinations may contribute to early access to cancer care, and are associated with less expensive treatments at the early stage.

This review found the estimation of non-medical costs and indirect costs varied across studies, and thus the ranges of non-medical costs and indirect costs as a percentage of direct cost and overall cost for cancer care were wide. There are insufficient details to allow us to break down the analysis of non-medical costs for transportation and lodging, additional nutrition products, or hiring a care worker. Indirect costs often refer to time or productivity loss of cancer patients or their family caregivers, but the measure is not consistent across studies. The available data imply the importance of measuring the financial burden considering relevant cost components in order to propose strategies to mitigate financial risks as a result of cancer care.

This review demonstrated that direct costs incurred by cancer care imposed a heavy financial burden on the affected families and more than half the households faced catastrophic health expenditures. The most common coping strategy was to borrow money. Meanwhile, the households reduced family expenses and even expenses on basic health services. Elderly cancer patients often paid less for cancer care; they have limited capacity to pay and are afraid of the financial burden extended to their adult children. For childhood cancers, some families received charity assistance or government subsidy; however, the indirect costs due to taking of care ill children were often high. Thus, efforts to provide financial protection for the cancer affected families should consider a wide range of cost impacts.

**Policy and research implications**

Cancer is a major cause of premature death and often exposes people to an economic shock, which disproportionately affects individuals in low- and middle-income countries. A global survey led by WHO found a vast majority of countries developed cancer or NCD prevention and control policies, strategies or plans. However, knowledge of the effective implementation of the national plans remains limited including practical priorities, resource allocation, a means of evaluation and others. A global analysis highlights context-specific evidence for cancer control plan development in low- and middle-income countries. We interpreted...
findings embedded in the comprehensive health system reform in China and proposed relevant policy and research implications, which would be also valuable for other low- and middle-income countries facing similar challenges.

In correspondence with the national health plan “Healthy China 2030,” China’s Cancer Prevention and Treatment Action Plan (2015–2017) highlighted strengthening stewardship for cancer control including multi-sector cooperation to mitigate the risk of financial hardship. Compared to the 2012 national essential medicine list, eleven new anti-tumor medicines were included in 2018. In the same year, the first list of generic drugs, a total of 34 drugs, was published. More anti-tumor medicines are also included in the reimbursement list of essential health insurance schemes through government drug procurement in recent years. In this review, a vast majority of studies were conducted before 2018. The effects of cancer control strategies adopted recently need further monitoring. Our review showed that the financial burden remains high, especially high for studies conducted after 2015 compared to the studies conducted before 2015 or for the same type of cancer. This may be partially attributed to a rapid increase in health expenditure on cancer-related new diagnoses and therapies; however, many expensive innovative approaches show only modest benefits for cancer control according to the WHO report on cancer in 2020.

The overview of ten years of health system reform in China identified the remaining inefficiency in service delivery and uncontrolled escalation of health expenditures. Public hospital financing reform including removing drug mark-ups shows an intended effect of hospital revenue decline from pharmaceutical sales. There are also unexpected impacts on the increase of expenditure for inpatient and outpatient care and problems with drug access. The major drivers of medical costs for cancer care including costs of inpatient care and patients’ self-purchasing drugs may incite improvement in regulations on cancer clinical services and ensure the security of the medicine and the drug supply to promote value-based cancer care. Additional public and private financial protection schemes and medical assistance (e.g. charity or government subsidy etc.) should be further explored and aim to prevent socio-economic vulnerable people from financial hardship caused by cancer care. To achieve the targets of cost control and financial risk protection for cancer affected families, China should strengthen governance of the health system and monitoring and evaluation of the related strategies implementation.

This review also has implications for future research. First, data on costs, particularly non-medical, and indirect costs are inconsistent across studies. To gain a better understanding of the components and structures of costs as well as the financial burden of cancer care, a study tool should be standardized and validated in the context. A longitudinal design will be optimal. Secondly, qualitative or mixed-methods research is needed to gain deeper knowledge on cancer care access, particularly the impact of financial toxicity, to inform interventions supporting vulnerable population. Thirdly, health policy and system research should be conducted to assess related policy implementations and provide evidence-based recommendations to improve quality and equality in cancer control.

**Strengths and limitations**

This review generated country-specific evidence on cost drivers and the financial burden of cancer care in the context of the new round of health system reform in China; however, the review had several limitations. First, how outcomes were defined and how data were collected and analyzed, particularly non-medical and indirect costs, varied considerably across the studies. The estimation and interpretation of the financial burden in this review were mainly based on medical costs. Secondly, the number of studies that allow us to conduct sub-group analysis by patients’ demographic and socio-economic status was limited. We were unable to run a meta-regression to examine the association between patients’ characteristics and the financial burden observed. Thirdly, the search strategy was not optimal to identifying studies only reporting the coping strategies used by the cancer affected households. The literature on coping with the costs of cancer care may not be fully covered. Qualitative studies will be more suitable to deeply exploring common or unintended coping strategies.

**Conclusions**

Although China has introduced relevant policies aiming to provide financial protection for access to cancer care in the context of the ongoing health system reform, this review demonstrated that costs of inpatient care and self-purchasing drugs are major drivers of medical costs for cancer care in China, and the financial burden for the affected families remains very heavy. Addressing this burden will require strengthening stewardship for cancer control and multi-sector cooperation to mitigate the risk of financial hardship. This will also require further in-depth research to gain a better understanding of individual, social and health system determinants of the
quality of cancer care, in terms of cost containment and financial risk protection, in order to inform cancer control policy development in China.

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials: Data sharing is not applicable to this article as no datasets were generated or analysed during the current study. All data were extracted from the published studies or their open access supplementary files.

Author Contributions: QL initiated the study concept, proposed data analysis, and contributed to the interpretation of the results, and drafted the manuscript. YJ participated in the study design, was responsible for citations screening, data extraction and analysis, and participated in manuscript writing. WJ and BY participated in screening, data extraction, and quality assessment of the studies included. ST supported the study design, and interpretations of results and manuscript writing.

Conflict of Interest Disclosures: All authors declare that they have no conflict of interest.

Funding/Support: No additional funding for this work.

Acknowledgment: We are grateful for the support from the students who made contributions to this study. We also express our sincere appreciation to Meng-Jie Zou, a library specialist from Duke Kunshan University, for her support in developing the search strategies and conducting the search for English and Chinese databases. We would like to thank authors who responded and clarified issues for data extraction.

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Tables

Table 1 is available in the Supplementary Files section.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1.docx
- Table1.docx
- Additionalfile2.pdf