BMJ Global Health

The financial toxicity of cancer: unveiling global burden and risk factors – a systematic review and meta-analysis

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ABSTRACT

Background Cancer, a major global health challenge, not only threatens lives but also imposes severe financial burdens, known as 'financial toxicity'. This strain extends beyond treatment costs to include indirect expenses like lost income and out-of-pocket payments. Despite its urgency, global insights remain fragmented, often limited to specific regions with inconsistent findings. This systematic review and meta-analysis aims to provide a comprehensive overview of cancer-related financial toxicity and identify key risk factors contributing to this burden.

Methods We conducted a systematic review and meta-analysis, searching databases like Medline, Web of Science, PubMed, Scopus, International Scientific Indexing and Google Scholar for peer-reviewed observational studies. Data were extracted into Microsoft Excel 2021, and study quality was assessed using the Joanna Briggs Institute critical appraisal tool. Statistical analysis was performed using STATA V.17, with catastrophic health expenditures (CHEs) pooled via a random-effects model. Heterogeneity was explored to understand variations in study outcomes. Subgroup and sensitivity analyses were conducted to assess individual study impacts, while publication bias was evaluated using Begger and Egger's tests. Univariate meta-regression analysis determined the impact of study-level covariates on CHE estimates.

Results This analysis included 35 observational studies, covering 428 373 patients with cancer. The pooled prevalence of CHE was 56.1% (95% CI 48.3% to 63.8%). Key risk factors included large family size, low income, lack of health insurance, longer disease duration, older age and multiple treatments. Higher education levels were associated with reduced CHE risk.

Conclusion Over half of patients with cancer (56.1%) face catastrophic health expenditures, highlighting a severe financial burden. Addressing this issue requires expanding health insurance, providing financial support and ensuring affordable cancer care. Improving education access can also reduce CHE risk among patients with cancer.

INTRODUCTION

Healthcare is a fundamental right for every individual, essential at all stages of life and

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Financial toxicity is a recognised consequence of cancer treatment, significantly affecting patients' quality of life.
⇒ Previous studies have highlighted that patients with cancer often face catastrophic health expenditures (CHE), but the data are mostly regional, and there is limited understanding of the global impact.
⇒ Known risk factors include low-income, lack of health insurance and extensive treatment requirements, but these findings are fragmented and not consistently analysed on a global scale.

WHAT THIS STUDY ADDS

⇒ This study provides a comprehensive global overview of the financial toxicity associated with cancer, using data from 35 observational studies covering 428 373 patients.
⇒ It quantifies the global prevalence of CHEs among patients with cancer, revealing that 56.1% of patients experience CHE.
⇒ The study identifies critical risk factors, such as large family size, low income, lack of health insurance, older age and extended disease duration, while also highlighting the protective role of higher education.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study lays the groundwork for further global and region-specific research into financial toxicity, encouraging more consistent methodologies and comprehensive data collection.
⇒ Healthcare providers may use these findings to better identify at-risk populations and tailor financial counselling and support services to mitigate financial toxicity in cancer care.
⇒ The findings underscore the need for policies that expand health insurance coverage, provide financial assistance to low-income families and ensure affordable cancer care. Additionally, they suggest that improving educational opportunities could be a strategic factor in reducing the financial burden on patients with cancer.

should not be influenced by one's wealth or income.[1] However, many people still face significant barriers to accessing necessary care due to financial constraints.[2] Households lacking sufficient financial protection are at risk of facing substantial unexpected medical costs. Such unforeseen expenses can result in severe debt, diminished living standards, and, eventually, financial hardship.[3] The situation becomes even more dire when dealing with cancer, as the financial strain can intensify significantly. Each year, around 8.8 million people die from cancer, making it one of the leading causes of death worldwide. Alarmingly, 75% of these cancer-related deaths occur in low-income and middle-income countries (LMICs).[4]

Cancer treatment involves a multifaceted array of costs that extend beyond the price of medical care. Direct costs include expenses for diagnosis, hospitalisation, surgery, chemotherapy, radiation therapy, and supportive care.[5] Indirect costs, on the other hand, involve lost income due to time off work, reduced productivity, and the need for ongoing care and support. For many patients, these costs can be overwhelming, leading to financial strain that can impact their ability to access necessary care and maintain a decent quality of life.[6] In LMICs, the absence of universal health coverage and the high cost of cancer treatments place an even greater strain on patients.[7] In these settings, the lack of financial protection can force individuals to forgo or delay treatment, resulting in poorer outcomes and increased mortality.[8]

Healthcare expenditure is deemed 'catastrophic' when out-of-pocket (OOP) costs significantly surpass a certain percentage of a household's income or financial capacity.[9] Catastrophic health expenditures (CHE) can force households to cut back on essential goods, and in some cases, patients may opt to forgo medical care altogether, leading to worsened health conditions.[10 11] Catastrophic health spending occurs when the amount a household pays OOP exceeds a predefined share of its capacity to pay for healthcare.[12]

Annually, over 150 million people worldwide experience financial catastrophe due to healthcare costs, with around 100 million falling into poverty as a result.[13] Additionally, a study conducted across 133 countries revealed that the incidence of CHE rose from 9.7% to 11.7% between 2005 and 2010.[14] Among patients with cancer, the incidence of CHE varies widely, ranging from 14.8% to 78.8%.[15] Research has shown that financial stress and concerns about paying medical bills related to cancer vary widely, with prevalence rates ranging from 22.5% in a nationally representative sample[16] to 64% among working-age cancer survivors.[17] Nearly two-thirds of cancer survivors (63.8%) were deeply concerned about paying large medical bills, while over one-third (33.6%) found themselves in debt, and 3.1% had to resort to filing for bankruptcy. Additionally, 39.7% were forced to make significant financial sacrifices due to the burden of cancer and its treatment.[18]

Sociodemographic risk factors significantly impact financial hardship among patients with cancer. Younger individuals often face higher financial strain due to limited savings and lack of Medicare coverage, making them more vulnerable to financial hardship compared with older patients.[19] Low-income patients with cancer are also at increased risk, though no specific income threshold is consistently identified.[20] Employment loss exacerbates financial difficulties, as cancer survivors frequently face challenges returning to work.[21 22] Health insurance coverage partially mitigates financial stress but does not eliminate OOP costs, especially for high-cost drugs.[23]

Cancer's financial impact is profound, often leading to CHEs, debt and even bankruptcy, significantly affecting patients' quality of life and treatment outcomes. Despite the growing recognition of this issue, comprehensive data on the global burden and risk factors for financial toxicity in cancer care are limited. This systematic review and meta-analysis aim to fill this gap by examining existing evidence, identifying key risk factors and informing targeted interventions. The study's findings will be crucial for shaping healthcare policies and support systems to alleviate financial distress among patients with cancer globally.

METHODS

Protocol development and registration

The systematic review protocol followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and is registered in the PROSPERO database under the registration number CRD42024574240. (online supplemental appendix 1). The study also adheres to the standard GATHER checklist, ensuring compliance with reporting recommendations for global estimates (online supplemental appendix 2).

Search strategy

We conducted a systematic review and meta-analysis to derive summary estimates. Initial searches were executed on 1 February 2024–5 February 2024 and updated on 8 April 2024. We searched peer-reviewed databases including Medline, Web of Science, PubMed, Scopus, International scientific indexing and Google Scholar databases. Articles were identified using a broad search strategy tailored for peer-reviewed literature. Search terms related to catastrophic health expenditures (eg, "catastrophic health expenditures," "financial burden," "out-of-pocket costs") and cancer (eg, "cancer," "oncology," "neoplasm") were used. Grey literature sources were selected based on prior reviews and expert consultations, with the complete list of websites searched provided (online supplemental appendix 3). Since estimates related to health expenditures may be under-represented in peer-reviewed literature, grey literature sources were also searched to ensure comprehensive coverage of relevant reports and estimates. We employed the snowballing technique to identify additional studies by examining the citation lists of the articles included in our initial search.

Eligibility criteria

Observational studies, including those from theses and dissertations, were eligible if they met the following criteria: published in or after 2010 and provided at least one of these elements: (1) an estimate of the prevalence of CHEs among patients with cancer; (2) an analysis of risk factors associated with CHEs in this population or (3) insights into the financial impacts on patients with cancer. Studies in languages other than English were included, with translations performed either by a research team member or using Google Translate. Excluded studies were those that did not present original research, involved non-human subjects, were clinical trials or used case–control or trial methodologies. Additionally, studies with fewer than 40 participants or those with a sample based on a clinical diagnosis unrelated to cancer were excluded. We also reviewed the reference lists of identified reviews to find any additional relevant studies not captured in our initial searches.

Study selection process

Results from the peer-reviewed searches were first de-duplicated in EndNote 20 and then exported to Covidence for screening. Each title and abstract was assessed by two team members (inter-rater agreement=69.1%, Cohen's κ=0.50), and each full-text article was reviewed (inter-rater agreement=86.1%, Cohen's κ=0.54) for inclusion. Discrepancies were resolved by consensus. Grey literature reports were managed in EndNote, with each paper also screened for inclusion by two independent reviewers.

Data extraction process

Studies were extracted into Microsoft Excel 2021 by (TAK and RNH). Extractions were double-checked by a second team member from the same group (AG and BDT), and conflicts were resolved through discussion. Data extracted included authors and study year, location, study design, sex, age, time period at which CHE were measured, outcome measurement criteria, sample size, the number of participants facing CHE, types of cancer and risk factors for CHE (online supplemental appendix 4). Summary estimates were sought, and data were extracted for the entire cohort and specific subgroups (eg, by cancer type, sex or age group). For studies reporting disaggregated estimates, data were extracted separately when possible. A full list of the variables extracted is available in the.

Risk of bias assessment

The Joanna Briggs Institute (JBI) critical appraisal tool was employed to assess the methodological quality of studies. Two independent reviewers evaluated each study using a series of questions with 'yes', 'no' or 'unclear' responses. To ensure objectivity, disagreements were resolved through consensus among the authors and an independent reviewer. Scores were assigned as follows: 1 for 'yes', 0 for 'no' and 'U' for 'unclear'. These scores were converted into percentages to determine the risk of bias: ≤49% indicated high risk, 50%–69% indicated moderate risk and above 70% indicated low risk. Only studies scoring at least 50% (moderate or low risk of bias) were included. For ongoing disagreements, individual ratings were averaged. Each primary study's quality was recorded in a specific column within the data extraction form to facilitate further analysis.

Definitions

The financial toxicity of cancer was defined by CHE. CHE is measured in three ways: (1) OOP healthcare costs exceed 10% of total household spending, (2) CHE at a threshold above 20% of total household expenditure and (3) households with OOP payments greater than 40% of their capacity to pay for healthcare. CHE refers to OOP medical costs, encompassing both direct and indirect costs. 'Capacity to pay' refers to the financial ability of an individual or household to pay for healthcare expenses without experiencing significant financial hardship. It is typically defined as the proportion of a household's income or resources that can be spent on healthcare while still meeting basic living needs, such as food, housing and education. 'Cost' refers to the total amount incurred for healthcare services, including both direct and indirect costs, while 'expenditure' refers to the actual OOP payments made by individuals or households for healthcare.[24–26]

Statistical analysis

Once data extraction was completed in Microsoft Excel, the data were imported into STATA V.17 for analysis. Qualitative and narrative methods were employed to summarise the estimates from the included studies. Qualitative methods identified key patterns, focusing on variations in study designs, populations and outcomes. Narrative methods systematically summarised the findings, highlighting similarities, differences and trends. When multiple estimates on the same topic were available, we used either the range of estimates or a pooled estimate. The SE was computed using a binomial distribution formula. CHEs were pooled using a random-effects model, accounting for the high level of heterogeneity observed between studies. To assess heterogeneity among studies, we calculated Cochrane's Q statistics (χ^2), inverse variance (I^2) and p values. An I^2 value of 0 indicated complete homogeneity, while I^2 values of 25%, 50% and 75% indicated low, moderate and high heterogeneity, respectively. Subgroup analyses were conducted based on study design, age category, country income level, sex, cancer type, outcome measurement, study period and JBI quality score (%). This allowed for examination of variations in prevalence estimates across different contexts and study characteristics. Sensitivity analysis, or leave-one-out meta-analysis, was performed to determine the influence of individual studies on the overall pooled estimates. Additionally, we evaluated publication bias using Begger and Egger's regression tests and constructed a funnel plot to visualise potential asymmetry. A Galbraith

plot was used to explore heterogeneity further and identify potential outliers. Univariate meta-regression analysis was also conducted to determine the impact of study-level covariates on the overall estimates of CHE.

Patient and public involvement

This research did not have patient or public involvement.

RESULTS

Initially, a total of 709 articles were identified: 674 from electronic databases, 27 from registers and 8 from other sources. Among the articles identified from database searches and registers, 398 were excluded as duplicates, and 7 were marked as ineligible by automation tools (using a classifier to eliminate records before screening). Furthermore, a detailed review of titles and abstracts led to the exclusion of 227 records. Of the 69 records sought for retrieval, 5 were not retrieved. From the 64 reports assessed for eligibility, 24 were excluded for not reporting the outcome of interest, 2 had quality issues, 4 had an incorrect population and 1 was available only as an abstract, leaving 33 articles that met the inclusion criteria. Additionally, of the eight articles identified through other methods and sought for retrieval, four were not retrieved. Of the remaining four articles, two were excluded, leaving two eligible articles. Consequently, a total of 35 articles met the inclusion criteria and were included in the systematic review and meta-analysis[27–60] (figure 1).

Characteristics and quality of the included studies

This systematic review and meta-analysis include studies from diverse continents, with the majority originating from Asia (24 studies) and Africa (7 studies). The predominant study design is cross-sectional (25 studies), followed by cohort studies (10 studies). The sample sizes vary considerably, ranging from 52 to 365 367 participants, aggregating to a total of 428 373 patients with cancer. The methodological quality of the included studies is generally high, as evaluated using the JBI criteria, with 89% of studies achieving scores above 70%. The prevalence of CHE differed significantly. All the studies included in this review are based on nationally representative populations (table 1).

Prevalence of CHE

This meta-analysis identified substantial heterogeneity across the studies (I^2=99.96%, p<0.001, H^2=2232.51 and T^2=0.0541). As a result, we used a random effects model to estimate the pooled prevalence of CHE. The results from 35 studies revealed that the pooled prevalence of CHE among patients with cancer is 56.1% (95% CI 48.3% to 63.8%) (figure 2). In addition, a Galbraith plot indicates a non-zero overall effect, as the regression line deviates from the no-effect line. While most studies fall within the CI, suggesting no significant outliers. The scattered distribution of points confirms heterogeneity among the studies (online supplemental appendix 5).
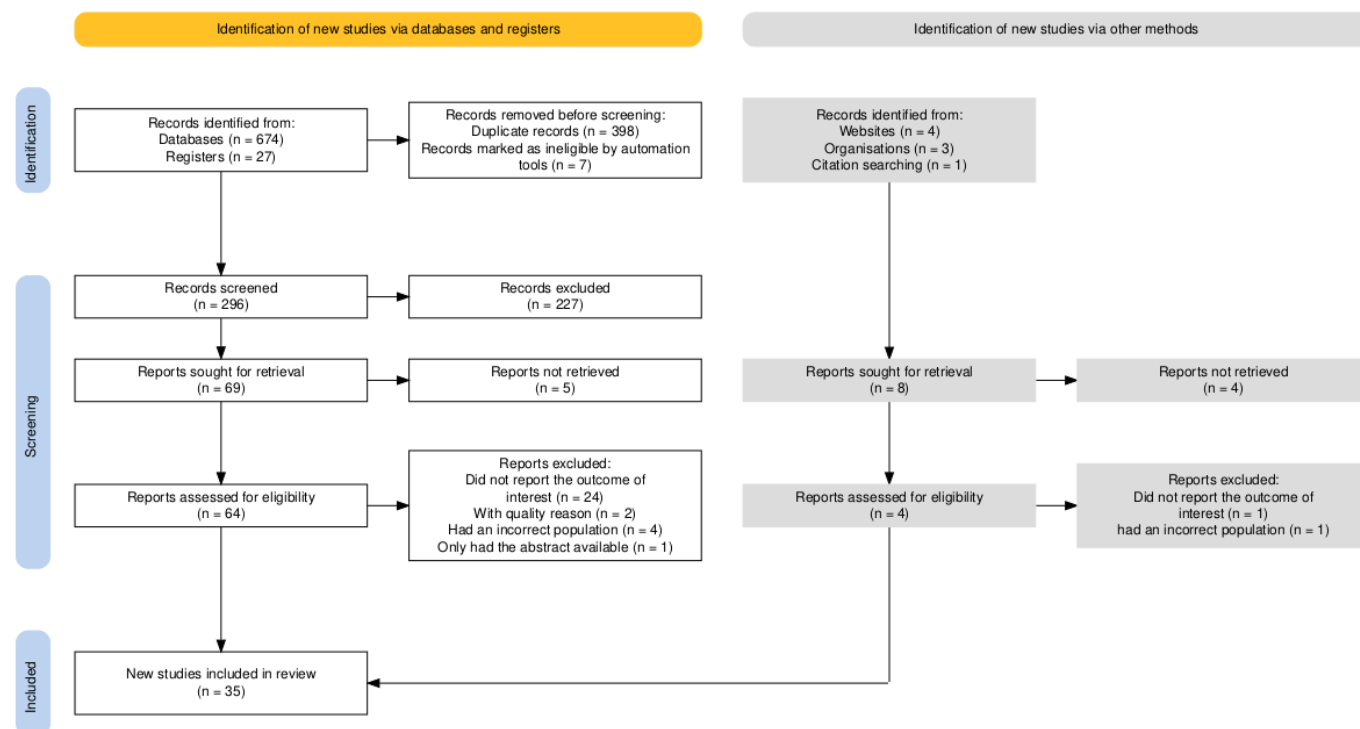

Figure 1 PRISMA flow chart for the selection of studies in a systematic review and meta-analysis of prevalence and risk factors of catastrophic health expenditure among patients with cancer. RISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1 Basic characteristics and quality of the included studies in a systematic review and meta-analysis of prevalence and risk factors of catastrophic health expenditure among patients with cancer

No	Authors name	Study setting	Study design	Sex	Cancer type	JBI (%)	Outcome measure	Sample size	Outcome	Prevalence
1	Ahmadi et al[27]	Iran	Cross-sectional	Female	Breast cancer	72.7	>40% of capacity to pay	138	19	0.138
2	Alinezhad et al[28]	Iran	Cross-sectional	Male	prostate cancer	90.9	>40% of capacity to pay	297	92	0.310
3	Zheng et al[29]	China	Cross-sectional	both	All cancer	90.9	>40% of capacity to pay	1344	575	0.428
4	Azzani et al[30]	Malaysia	Cross-sectional	Both	Colorectal cancer	81.8	>40% of capacity to pay	138	66	0.478
5	Basavaiah et al[31]	India	Cohort study	Both	Pancreatic cancer	90.9	>10% of total income	98	75	0.765
6	Jane Bates et al[32]	Malawi	Cohort study	Both	All cancer	63.6	>20% of total income	89	57	0.640
7	Berlin et al[33]	USA	Cross-sectional	Female	Breast cancer	90.9	>10% of total income	1496	476	0.318
8	Bhoo-Pathy et al[34]	Malaysia	Cohort study	Both	All cancer	81.8	>20% of total income	1294	665	0.514
9	Chauhan et al[35]	India	Cohort study	Both	Head and neck cancer	81.8	>40% of capacity to pay	410	141	0.344
10	Choi et al[36]	South Korea	Cross-sectional	Both	All cancer	72.7	>10% of total income	212	84	0.396
11	CROCODILE study group	India	Cohort study	Both	Colorectal cancer	81.8	>20% of total income	202	182	0.901
12	Deng et al[37]	China	Cross-sectional	Both	All cancer	81.8	>40% of capacity to pay	388	198	0.510
13	Fekri et al[38]	Iran	Cross-sectional	Both	All cancer	90.9	>20% of total income	38146	2861	0.075
14	Fu et al[39]	China	Cross-sectional	Both	All cancer	90.9	>40% of capacity to pay	2534	1825	0.720
15	Hoang et al[42]	Vietnam	Cohort study	Both	All cancer	90.9	>40% of capacity to pay	10000	6470	0.647
16	Kasahun et al[43]	Ethiopia	Cross-sectional	Both	All cancer	81.8	>40% of capacity to pay	352	262	0.744
17	Kavosi et al[44]	Iran	Cross-sectional	Both	All cancer	72.7	>40% of capacity to pay	245	163	0.665
18	Leng et al[45]	China	Cross-sectional	Both	All cancer	81.8	>40% of capacity to pay	792	758	0.957
19	Liew et al[46]	Malaysia	Cross-sectional	Female	Gynaecological cancer	81.8	>10% of total income	120	77	0.642

Continued

Table 1 Continued

No	Authors name	Study setting	Study design	Sex	Cancer type	JBI (%)	Outcome measure	Sample size	Outcome	Prevalence
20	Matebie et al[47]	Ethiopia	Cross-sectional	Both	All cancer	72.7	>40% of capacity to pay	305	237	0.777
21	Maurya et al[48]	India	Cross-sectional	Both	All cancer	90.9	>40% of capacity to pay	474	292	0.616
22	Mohanty et al[49]	India	Cohort study	Women	Breast cancer	100.0	>40% of capacity to pay	429	363	0.846
23	Piroozi et al[50]	Iran	Cross-sectional	Both	Gastrointestinal cancer	81.8	>40% of capacity to pay	189	117	0.619
24	Prinja et al[51]	India	Cross-sectional	Both	All cancer	81.8	>40% of capacity to pay	12148	8661	0.713
25	Raman et al[52]	Malaysia	Cross-sectional	Both	Oral cancer	81.8	>10% of total income	52	45	0.865
26	Rezapour et al[53]	Iran	Cross-sectional	Both	All cancer	63.6	>40% of capacity to pay	220	154	0.700
27	Rice et al[54]	USA	Cross-sectional	Both	Gastrointestinal cancer	100.0	>40% of capacity to pay	365367	25956	0.071
28	Sui et al[55]	China	Cross-sectional	Both	Leukaemia	90.9	>40% of capacity to pay	242	105	0.434
29	Sun et al[56]	China	Cross-sectional	Female	Breast cancer	81.8	>40% of capacity to pay	639	562	0.879
30	Sun et al[57]	China	Cohort study	Both	Lung cancer	81.8	>40% of capacity to pay	470	367	0.781
31	The ACTION Study Group	Southeast Asia	Cohort study	Female	All cancer	81.8	>20% of total income	6787	3248	0.479
32	Wan Puteh et al[58]	Malaysia	Cross-sectional	Both	All cancer	72.7	>10% of total income	630	343	0.544
33	Zarezadeh et al[59]	Iran	Cross-sectional	Both	All cancer	72.7	>40% of capacity to pay	101	43	0.426
34	Zhao et al[60]	China	Cross-sectional	Both	All cancer	72.7	>40% of capacity to pay	368	100	0.272
35	Zheng et al[29]	China	Cross-sectional	Both	All cancer	90.9	>40% of capacity to pay	1344	575	0.428

JBI, Joanna Briggs Institute.

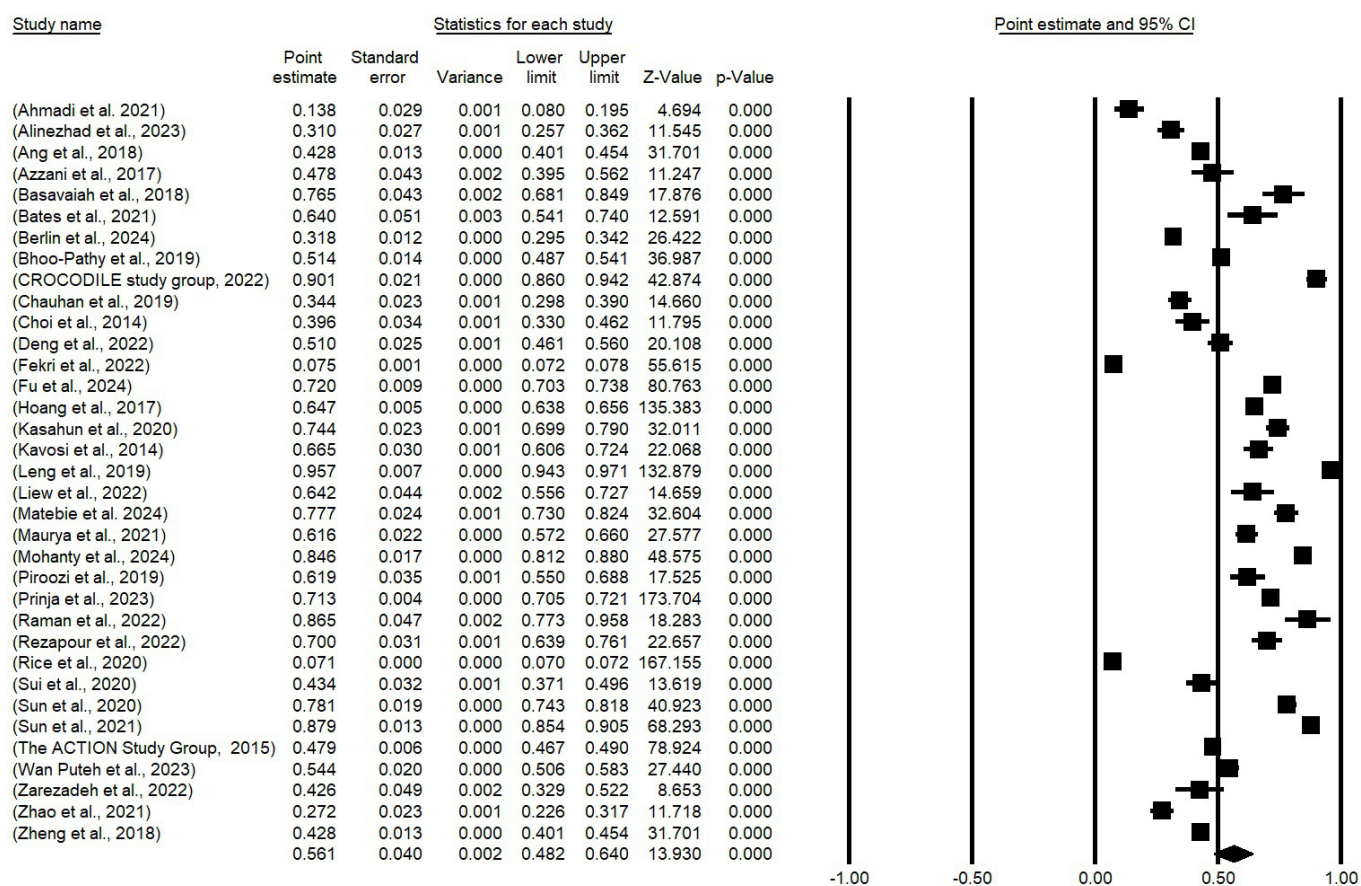| Study name	Statistics for each study							Point estimate and 95% CI
	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	
(Ahmadi et al. 2021)	0.138	0.029	0.001	0.080	0.195	4.694	0.000	
(Alinezhad et al., 2023)	0.310	0.027	0.001	0.257	0.362	11.545	0.000	
(Ang et al., 2018)	0.428	0.013	0.000	0.401	0.454	31.701	0.000	
(Azzani et al., 2017)	0.478	0.043	0.002	0.395	0.562	11.247	0.000	
(Basavaiah et al., 2018)	0.765	0.043	0.002	0.681	0.849	17.876	0.000	
(Bates et al., 2021)	0.640	0.051	0.003	0.541	0.740	12.591	0.000	
(Berlin et al., 2024)	0.318	0.012	0.000	0.295	0.342	26.422	0.000	
(Bhoo-Pathy et al., 2019)	0.514	0.014	0.000	0.487	0.541	36.987	0.000	
(CROCODILE study group, 2022)	0.901	0.021	0.000	0.860	0.942	42.874	0.000	
(Chauhan et al., 2019)	0.344	0.023	0.001	0.298	0.390	14.660	0.000	
(Choi et al., 2014)	0.396	0.034	0.001	0.330	0.462	11.795	0.000	
(Deng et al., 2022)	0.510	0.025	0.001	0.461	0.560	20.108	0.000	
(Fekri et al., 2022)	0.075	0.001	0.000	0.072	0.078	55.615	0.000	
(Fu et al., 2024)	0.720	0.009	0.000	0.703	0.738	80.763	0.000	
(Hoang et al., 2017)	0.647	0.005	0.000	0.638	0.656	135.383	0.000	
(Kasahun et al., 2020)	0.744	0.023	0.001	0.699	0.790	32.011	0.000	
(Kavosi et al., 2014)	0.665	0.030	0.001	0.606	0.724	22.068	0.000	
(Leng et al., 2019)	0.957	0.007	0.000	0.943	0.971	132.879	0.000	
(Liew et al., 2022)	0.642	0.044	0.002	0.556	0.727	14.659	0.000	
(Matebie et al. 2024)	0.777	0.024	0.001	0.730	0.824	32.604	0.000	
(Maurya et al., 2021)	0.616	0.022	0.000	0.572	0.660	27.577	0.000	
(Mohanty et al., 2024)	0.846	0.017	0.000	0.812	0.880	48.575	0.000	
(Piroozi et al., 2019)	0.619	0.035	0.001	0.550	0.688	17.525	0.000	
(Prinja et al., 2023)	0.713	0.004	0.000	0.705	0.721	173.704	0.000	
(Raman et al., 2022)	0.865	0.047	0.002	0.773	0.958	18.283	0.000	
(Rezapour et al., 2022)	0.700	0.031	0.001	0.639	0.761	22.657	0.000	
(Rice et al., 2020)	0.071	0.000	0.000	0.070	0.072	167.155	0.000	
(Sui et al., 2020)	0.434	0.032	0.001	0.371	0.496	13.619	0.000	
(Sun et al., 2020)	0.781	0.019	0.000	0.743	0.818	40.923	0.000	
(Sun et al., 2021)	0.879	0.013	0.000	0.854	0.905	68.293	0.000	
(The ACTION Study Group, 2015)	0.479	0.006	0.000	0.467	0.490	78.924	0.000	
(Wan Puteh et al., 2023)	0.544	0.020	0.000	0.506	0.583	27.440	0.000	
(Zarezadeh et al., 2022)	0.426	0.049	0.002	0.329	0.522	8.653	0.000	
(Zhao et al., 2021)	0.272	0.023	0.001	0.226	0.317	11.718	0.000	
(Zheng et al., 2018)	0.428	0.013	0.000	0.401	0.454	31.701	0.000	
	0.561	0.040	0.002	0.482	0.640	13.930	0.000	

Figure 2 A forest plot on the pooled prevalence of catastrophic health expenditure among patients with cancer.

Publication bias

Publication bias was evaluated using both Begg's and Egger's tests, which provide objective measures of bias. The results from Begg's test (p=0.9101) and Egger's test (p=0.4227) indicated no evidence of publication bias.

Subgroup analysis

Subgroup analysis was done considering study design, age category, countries income level, sex, cancer type, age category, outcome measurement, period and JBI (%). Thus, there is high prevalence of CHE in 73.3% (95% CI 66.6% to 80.0%) as compared with middle income (57.6%) and high-income countries (26.0%). Regarding the types of cancer, high polled prevalence of CEH (58.6%) (95% CI 28.9% to 88.3%) is reported among patients with gastrointestinal cancer. Concerning the CHE measurement criteria, the prevalence of CHE is 60.8% as measured by threshold of greater than 10% of annual income, 52.1% at threshold of >20% of annual income and 55.5% as measured by >40% of capacity to pay as recommended measurement of CHE by WHO. The polled prevalence of CHE is also vary as measured in different time interval from diagnosis of cancer. Thus, CHE is found to be high at 24 months after diagnosis (83.0%) and it was 65.2% and 62.8% at 12 and 6 months, respectively (figure 3).

Sensitivity analysis

Leave-one-out analysis was also conducted to explore the influence of a single study on the overall effect size estimate. A leave-one-out meta-analysis omits the corresponding study, and a meta-analysis is performed on the remaining studies (n=1). If the cross-ponding study CI does not include the overall effect size estimate (theta), it is declared that the study significantly influences the overall effect size estimate. In this study, the general effect size estimate (theta) was 0.561 and was included within the confidence intervals of all the studies. Thus, omitting one study did not significantly influence the overall effect size estimate (online supplemental appendix 6).

Risk factors of CHE

Different studies have identified various factors contributing to CHE. These factors include unemployment,[36–38] large family size,[29 36] low-income level,[34 35 40 42 47 50 51 55 58] lack of health insurance,[29 34 40 47 50] prolonged disease course (greater than 1 year),[29 36 56 57] older age,[27 39 42 43 56] higher education level (university and above)[27 29 57] and being on multiple treatments.[42 56 58]

The odds of experiencing CHE among patients with cancer are significantly influenced by various factors. Patients with cancer with large families have a 1.29 times higher likelihood of incurring CHE (AOR 1.29,
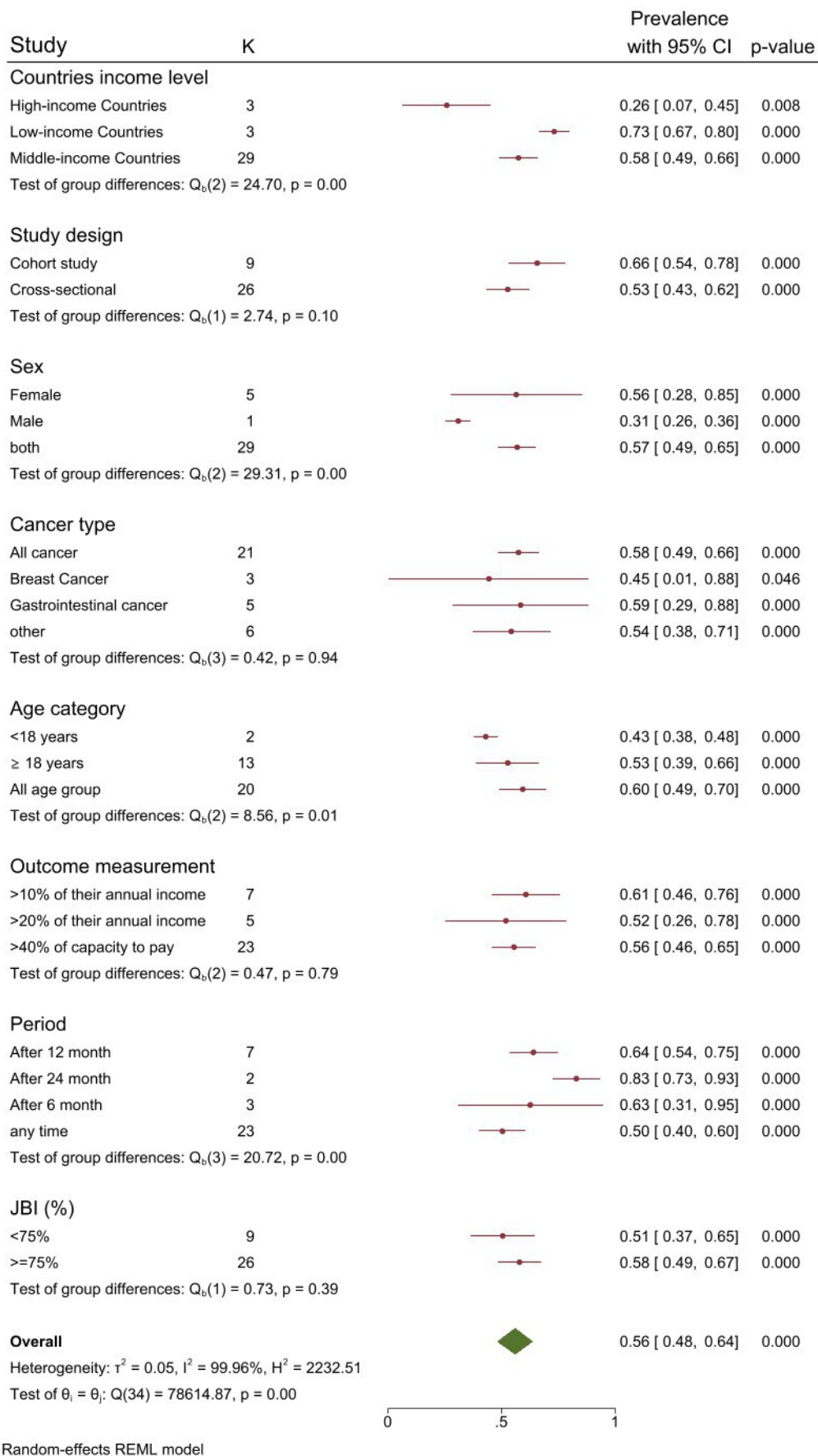
Study	K		Prevalence with 95% CI	p-value
Countries income level				
High-income Countries	3		0.26 [0.07, 0.45]	0.008
Low-income Countries	3		0.73 [0.67, 0.80]	0.000
Middle-income Countries	29		0.58 [0.49, 0.66]	0.000
Test of group differences: $Q_b(2) = 24.70$, p = 0.00				
Study design				
Cohort study	9		0.66 [0.54, 0.78]	0.000
Cross-sectional	26		0.53 [0.43, 0.62]	0.000
Test of group differences: $Q_b(1) = 2.74$, p = 0.10				
Sex				
Female	5		0.56 [0.28, 0.85]	0.000
Male	1		0.31 [0.26, 0.36]	0.000
both	29		0.57 [0.49, 0.65]	0.000
Test of group differences: $Q_b(2) = 29.31$, p = 0.00				
Cancer type				
All cancer	21		0.58 [0.49, 0.66]	0.000
Breast Cancer	3		0.45 [0.01, 0.88]	0.046
Gastrointestinal cancer	5		0.59 [0.29, 0.88]	0.000
other	6		0.54 [0.38, 0.71]	0.000
Test of group differences: $Q_b(3) = 0.42$, p = 0.94				
Age category				
<18 years	2		0.43 [0.38, 0.48]	0.000
≥ 18 years	13		0.53 [0.39, 0.66]	0.000
All age group	20		0.60 [0.49, 0.70]	0.000
Test of group differences: $Q_b(2) = 8.56$, p = 0.01				
Outcome measurement				
>10% of their annual income	7		0.61 [0.46, 0.76]	0.000
>20% of their annual income	5		0.52 [0.26, 0.78]	0.000
>40% of capacity to pay	23		0.56 [0.46, 0.65]	0.000
Test of group differences: $Q_b(2) = 0.47$, p = 0.79				
Period				
After 12 month	7		0.64 [0.54, 0.75]	0.000
After 24 month	2		0.83 [0.73, 0.93]	0.000
After 6 month	3		0.63 [0.31, 0.95]	0.000
any time	23		0.50 [0.40, 0.60]	0.000
Test of group differences: $Q_b(3) = 20.72$, p = 0.00				
JBI (%)				
<75%	9		0.51 [0.37, 0.65]	0.000
>=75%	26		0.58 [0.49, 0.67]	0.000
Test of group differences: $Q_b(1) = 0.73$, p = 0.39				
Overall			0.56 [0.48, 0.64]	0.000
Heterogeneity: $\tau^2 = 0.05$, $I^2 = 99.96\%$, $H^2 = 2232.51$				
Test of $\theta_i = \theta_j$: $Q(34) = 78614.87$, p = 0.00				

Random-effects REML model

Figure 3 Subgroup analysis of the pooled prevalence of catastrophic health expenditure among patients with cancer. JBI, Joanna Briggs Institute; REML, random-effects model.

95% CI 1.07 to 1.49). Patients in low-income level face a substantially increased risk of CHE (AOR 5.57, 95% CI 3.86 to 7.29). Lack of health insurance increases the odds of CHE by 1.25 times (AOR 1.25, 95% CI 1.10 to 1.41). Additionally, the duration of cancer is associated with CHE risk, with patients having the disease for more than a year facing a 1.89 times higher likelihood (AOR 1.89, 95% CI 1.73 to 1.84). Older age increases the odds of CHE by 1.37 times (AOR 1.37, 95% CI 1.02 to 1.75). Higher education levels are protective, reducing the odds of CHE by 82% (AOR 0.18, 95% CI 0.11 to 0.26). Lastly, undergoing multiple treatments such as chemotherapy, surgery and radiotherapy significantly increases the likelihood of CHE, with these patients being 2.42 times more likely to incur it (AOR 2.42, 95% CI 1.57 to 3.26) (table 2).

Meta-regression analysis

Univariate meta-regression analysis was conducted to determine the impact of study-level covariates on the overall estimates of CHE. We included sample size, year of publication, study design, mean age and the timing of CHE measurement in the univariate meta-regression. The analysis indicated that there was no significant effect of study-level covariates on the overall effect size of CHE (online supplemental appendix 7).

DISCUSSION

This systematic review and meta-analysis aimed to estimate the global burden of CHE and identify key risk factors among patients with cancer. The pooled prevalence of CHE among patients with cancer, based on 35 studies, is 56.1% (95% CI 48.3% to 63.8%). This finding aligns with the range reported by Azzani *et al* (including 10 studies), which indicated a financial burden between 14.8% and 78.8%.[15] However, our results are higher than those of a previous systematic review by Doshmangir *et al* (including 19 studies), which found a CHE prevalence of 43.3%, ranging from 36.7% to 50.1%.[61] The higher prevalence of CHE among patients with cancer underscores the significant financial burden that cancer treatment imposes. Clinically, this financial strain can affect patient outcomes, as those facing CHE may delay or forgo necessary treatments, leading to poorer health outcomes. It highlights the need for healthcare providers to consider the financial aspects of cancer care and incorporate financial counselling and support services as part of comprehensive cancer care. From a policy perspective, these findings advocate for stronger health policies that protect patients with cancer from financial hardship. Policy-makers should consider expanding health insurance coverage, reducing OOP expenses and providing financial assistance programmes specifically targeted at patients with cancer. Additionally, our findings support the need for international efforts to address the financial barriers to cancer care, especially in low-income countries where patients are disproportionately affected.

Reducing the financial burden of cancer treatment can improve access to care, adherence to treatment, and ultimately, patient outcomes.

The subgroup analysis revealed that patients with cancer from low-income countries experience a significantly higher prevalence of CHE compared with those from middle-income and high-income countries (73% vs 58% and 26%, respectively). These findings align with previous studies.[15 61] It is also evident in risk identification analysis, which revealed patients with cancer from low-income countries face more than five and half times increased risk of CHE. This disparity underscores the urgent need for targeted financial support and health policy reforms to alleviate the CHE burden on patients with cancer in low-income countries.

Significantly high burden of CHE (59%) was also found in patients with gastrointestinal cancer than other cancer. The significantly high CHE among patients with gastrointestinal cancer can be attributed to several factors. These cancers often require complex and expensive treatments, including surgery, chemotherapy, radiation and targeted therapy.[62] The prolonged duration of care, frequent follow-up visits, high complication rates and hospitalisations further escalate medical expenses. Patients are often diagnosed at advanced stages, necessitating more intensive and costly treatments.[63] Addressing these issues through comprehensive insurance coverage, targeted financial assistance programmes and supportive care interventions is essential to alleviate the financial strain and reduce the prevalence of CHE among patients with gastrointestinal cancers.

CHE increased over time, with rates of 63%, 64% and 83% observed at 6 months, 12 months and 24 months after diagnosis, respectively. This escalation can be attributed to several factors. As treatment duration extends, costs for surgeries, chemotherapy, radiation and other therapies continue to accumulate. Additionally, the risk of complications and recurrences rises over time, resulting in further medical interventions and hospitalisations.[64]

Large family size and lack of health insurance are among the factor that makes the patients with cancer 1.29 and 1.25 at risk to face a CHE. Large family size can lead to CHE for patients with cancer because the financial burden of treatment is compounded by the higher overall living costs. With more dependents, a household's financial flexibility is reduced, making it harder to manage additional medical expenses. Larger families often have limited resources and may struggle to afford comprehensive health insurance, leading to gaps in coverage and increased risk of CHE. Lack of health insurance leads to CHE for patients with cancer because they face high costs for treatments like surgery, chemotherapy and radiation.[65] Without insurance, patients must cover these expenses OOP, leading to financial strain and potential delays in care. This can worsen health and increase long-term costs. High OOP expenses and accumulating medical debt without insurance further contribute to CHE, making patients more vulnerable to financial

Table 2 Risk factors of catastrophic health expenditure among patients with cancer

Risk factors	OR (95% CI)	Pooled AOR (95% CI)	I² (p value)	Egger (p value)	Sample size
Unemployment					
Choi et al, 2014[36]	2.63 (2.59 to 2.67)	2.05 (0.93 to 3.16)	99.81 (<0.001)	0.612	38 746
Deng et al, 2022[37]	2.68 (1.21 to 4.15)				
Fekri et al, 2022[38]	1.08 (1.01 to 1.15)				
Large family size					
Zheng et al, 2018[29]	1.17 (1.02 to 1.320)	1.29 (1.07 to 1.49)	90.89 (<0.001)	0.097	2900
Choi et al, 2014[36]	1.48 (1.45 to 1.52)				
Zheng et al, 2018[29]	1.17 (1.02 to 1.32)				
Being in low income level					
Bhoo-Pathy et al, 2019[34]	5.78 (3.64 to 7.93)	5.57 (3.86 to 7.29)	61.42 (<0.001)	0.392	32 005
Chauhan et al, 2019[35]	5.60 (0.70 to 10.50)				
Hoang et al, 2017[42]	2.89 (1.27 to 4.51)				
Matebie et al 2024[47]	9.80 (2.90 to 27.50)				
Piroozi et al, 2019[50]	7.10 (2.05 to 20.25)				
Prinja et al, 2023[51]	10.96 (6.92 to 15.01)				
Sui et al, 2020[55]	4.41 (13.46 to 12.28)				
The ACTION Study Group, 2015	5.86 (4.63 to 7.09)				
Wan Puteh et al, 2023[58]	4.66 (1.79 to 7.52)				
Health insurance status -Non-insured					
Zheng et al, 2018[29]	1.18 (1.01 to 1.35)	1.25 (1.10 to 1.41)	6.32 (<0.001)	0.117	9919
Bhoo-Pathy et al, 2019[34]	1.90 (1.25 to 2.56)				
Matebie et al, 2024[47]	5.60 (1.65 to 12.85)				
Piroozi et al, 2019[50]	3.80 (0.95 to 8.55)				
The ACTION Study Group, 2015	1.27 (1.04 to 1.51)				
Disease course (>1 year)					
Choi et al, 2014[36]	*1.78(1.76 to 1.81)*	1.89 (1.73 to 1.84)	3.80 (<0.001)	0.074	2665
Sun et al, 2021[56]	*5.69 (2.11 to 9.28)*				
Sun et al, 2021[57]	*2.74 (1.14 to 4.35)*				
Zheng et al, 2018[29]	*1.88 (1.67 to 2.09)*				
Older patients with cancer					
Ahmadi et al 2021[27]	*1.81 (0.80 to 2.82)*	1.37 (1.02 to 1.75)	70.02(<0.001)	0.061	13 494
Fu et al, 2024[39]	*1.34 (1.04 to 1.65)*				3465
Hoang et al, 2017[42]	*1.75 (0.78 to 2.73)*				
Kasahun et al, 2020[43]	*1.03 (1.01 to 1.06)*				
Sun et al, 2021[56]	*2.16 (1.01 to 3.38)*				
Education level (university and above)					
Ahmadi et al 2021[27]	*0.27(0.210 to 0.33)*	0.18 (0.11 to 0.26)	84.65(<0.001)	0.531	13 494
Zheng et al, 2018[29]	*0.14 (0.10 to 0.18)*				
Sun et al, 2021[57]	*0.27 (0.14 to 0.69)*				
Zheng et al, 2018[29]	*0.14 (0.10 to 0.18)*				
Multiple treatment					
Hoang et al, 2017[42]	*2.40 (1.01 to 3.79)*	2.42 (1.57 to 3.26)	0.00(<0.001)	0.516	11 269
Sun et al, 2021[56]	*2.38 (1.30 to 3.45)*				
Wan Puteh et al, 2023[58]	*4.99 (2.71 to 12.69)*				

hardship. To mitigate this burden, expanding affordable health insurance schemes that include comprehensive cancer care is crucial. Targeted financial support for large families, such as subsidies or cash transfers, can alleviate their heightened vulnerability. Additionally, community-based initiatives like pooled health funds and integration of financial counselling into oncology care can provide immediate relief. Promoting family planning and health education may also help reduce long-term financial strain, emphasising the importance of holistic, targeted interventions.

Older patients with cancer also suffer from CHE 1.37 times than other population group. This finding is in agreement with previous study.[24] Older patients with cancer typically have higher healthcare needs, often managing multiple comorbidities that necessitate frequent and extensive medical interventions, which significantly raise overall healthcare costs. Additionally, many older individuals depend on fixed incomes, such as pensions or savings, which may be insufficient to cover the high costs of cancer treatment.[66 67] This highlights the need for targeted financial support and better insurance coverage for this demographic.

As the duration of the cancer is beyond 1 year, the likelihood of suffering from CHE is increased by 1.89 times. Prolonged treatment often involves continuous medical appointments, procedures and therapies, leading to significant costs accumulating over time. Additionally, the financial strain can be compounded by the loss of income if patients or their caregivers are unable to work due to the demands of ongoing treatment and care.[68] This underscores the necessity for long-term financial planning, comprehensive insurance coverage and supportive policies to mitigate the financial burden on these patients and their families.

Being on multiple treatments simultaneously, such as chemotherapy and surgery, increases the risk of CHE by 2.42 times. The combined cost of different treatments can be exorbitant, as each treatment involves separate fees for medications, medical professionals and hospital stays. Additionally, multiple treatments often require extra supportive care and follow-up appointments, further increasing the financial burden.[69] Higher educational levels are found to be protective against CHE by 82%. Individuals with higher education often have better access to well-paying jobs, which translates to higher incomes and greater financial stability. This economic advantage allows them to better absorb the costs associated with severe illnesses, such as cancer. Additionally, higher education is often linked to better health literacy, enabling individuals to make informed decisions about their healthcare and navigate insurance options more effectively.[70] Policies that integrate education with health awareness, particularly in communities with low literacy levels, could serve as a long-term strategy to reduce financial toxicity among patients with cancer.

The study's reliance on observational data means that the relationships between CHE and its risk factors may not be causal. While subgroup analyses provide detailed insights into the prevalence of CHE using various measurements and definitions, the overall pooled prevalence may not accurately capture the true burden. Additionally, the concentration of studies in specific regions limits the global generalisability of the findings. Moreover, the high level of heterogeneity across studies is another limitation.

CONCLUSION

This systematic review and meta-analysis highlights the alarmingly high prevalence of CHE among patients with cancer, illustrating the substantial financial burden they endure. The analysis identified several critical risk factors associated with CHE. Patients with large families are at an elevated risk, indicating the need for tailored financial support programmes to ease the burden on these households. Low-income patients also face a significantly higher risk, underscoring the necessity for increasing direct financial assistance and broadening social safety nets. The lack of health insurance significantly contributes to the risk of CHE, emphasising the need for reforms aimed at expanding insurance coverage and making it more affordable. Additionally, the likelihood of CHE rises with prolonged illness, suggesting a need for developing financial support structures specifically designed for long-term cancer care. Older patients face heightened risks, which indicates a need for targeted financial support services that address the unique challenges of this demographic. For patients undergoing multiple treatments, there is a clear need for integrated financial support mechanisms that can accommodate the cumulative costs of various treatment modalities. Furthermore, education is a protective factor against CHE. Investing in educational programmes that improve financial literacy and planning could help mitigate the economic impact of cancer care. Developing community-based support systems that offer financial counselling and assistance can also play a critical role in addressing the financial challenges faced by patients with cancer.

By diversifying approaches-such as enhancing insurance options, expanding direct financial aid, creating targeted support services for older patients and investing in financial education—policy-makers can more effectively alleviate the financial strain on patients with cancer and improve their overall quality of life.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. The datasets used and/or analysed during the current study available from the corresponding author (TAK) on reasonable request.

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REFERENCES

1 Jakovljevic M, Timofeyev Y, Ekkert NV, *et al*. The impact of health expenditures on public health in BRICS nations. *J Sport Health Sci* 2019;8:516–9.
2 Kuteesa KN, Akpuokwe CU, Udeh CA. Financing models for global health initiatives: Lessons from maternal and gender equality programs. *Int Med Sci Res J* 2024;4:470–83.
3 Sachs JD. From millennium development goals to sustainable development goals. *Lancet* 2012;379:2206–11.
4 Prager GW, Braga S, Bystricky B, *et al*. Global cancer control: responding to the growing burden, rising costs and inequalities in access. *ESMO Open* 2018;3:e000285.
5 Yassine F, Kharfan-Dabaja MA. Patient resources in a cancer center. In: Aljurf M, Majhail NS, Koh MBC, et al, eds. *The comprehensive cancer center: development, integration, and implementation*. Cham (CH): Springer, 2022: 145–55.
6 Cong Z, Tran O, Nelson J, *et al*. Productivity Loss and Indirect Costs for Patients Newly Diagnosed with Early- versus Late-Stage Cancer in the USA: A Large-Scale Observational Research Study. *Appl Health Econ Health Policy* 2022;20:845–56.
7 Barrios C, de Lima Lopes G, Yusof MM, *et al*. Barriers in access to oncology drugs - a global crisis. *Nat Rev Clin Oncol* 2023;20:7–15.
8 Knaul F, Horton S, Yerramilli P, *et al*. Financing cancer care in low-resource settings. In: Gelband H, Jha P, Sankaranarayanan R, et al, eds. *Cancer: disease control priorities, third edition (volume 3)*. Washington (DC): The International Bank for Reconstruction and Development / The World Bank 2015 International Bank for Reconstruction and Development / The World Bank, 2015.
9 Xu Y, Gao J, Zhou Z, *et al*. Measurement and explanation of socioeconomic inequality in catastrophic health care expenditure: evidence from the rural areas of Shaanxi Province. *BMC Health Serv Res* 2015;15:256.
10 Zhou C, Long Q, Chen J, *et al*. The effect of NCMS on catastrophic health expenditure and impoverishment from tuberculosis care in China. *Int J Equity Health* 2016;15:172.
11 Si Y, Zhou Z, Su M, *et al*. Catastrophic healthcare expenditure and its inequality for households with hypertension: evidence from the rural areas of Shaanxi Province in China. *Int J Equity Health* 2017;16:27.
12 World Health Organization. Universal health coverage. 2019. Available: https://www.who.int/health-topics/universal-health-coverage
13 Xu K, Evans DB, Carrin G, *et al*. Protecting households from catastrophic health spending. *Health Aff (Millwood)* 2007;26:972–83.
14 Rao KD, Makimoto S, Peters M, *et al*. *Vulnerable populations and universal health coverage. Leave no one behind: time for specifics on the sustainable development goals*. 2019.
15 Azzani M, Roslani AC, Su TT. The perceived cancer-related financial hardship among patients and their families: a systematic review. *Support Care Cancer* 2015;23:889–98.
16 Yabroff KR, Dowling EC, Guy GP Jr, *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;34:259–67.
17 Ell K, Xie B, Wells A, *et al*. Economic stress among low-income women with cancer: effects on quality of life. *Cancer* 2008;112:616–25.
18 Jagsi R, Pottow JAE, Griffith KA, *et al*. Long-term financial burden of breast cancer: experiences of a diverse cohort of survivors identified through population-based registries. *J Clin Oncol* 2014;32:1269–76.
19 Shankaran V, Jolly S, Blough D, *et al*. Risk factors for financial hardship in patients receiving adjuvant chemotherapy for colon cancer: a population-based exploratory analysis. *J Clin Oncol* 2012;30:1608–14.
20 Chino F, Peppercorn J, Taylor DH Jr, *et al*. Self-reported financial burden and satisfaction with care among patients with cancer. *Oncologist* 2014;19:414–20.
21 Jagsi R, Ward KC, Abrahamse PH, *et al*. Unmet need for clinician engagement regarding financial toxicity after diagnosis of breast cancer. *Cancer* 2018;124:3668–76.
22 Palmer JD, Patel TT, Eldredge-Hindy H, *et al*. Patients Undergoing Radiation Therapy Are at Risk of Financial Toxicity: A Patient-based Prospective Survey Study. *Int J Radiat Oncol Biol Phys* 2018;101:299–305.
23 Kircher SM, Johansen ME, Nimeiri HS, *et al*. Impact of Medicare Part D on out-of-pocket drug costs and medical use for patients with cancer. *Cancer* 2014;120:3378–84.
24 Getachew N, Shigut H, Jeldu Edessa G, *et al*. Catastrophic health expenditure and associated factors among households of non community based health insurance districts, Ilubabor zone, Oromia regional state, southwest Ethiopia. *Int J Equity Health* 2023;22:40.
25 Shikuro D, Yitayal M, Kebede A, *et al*. Catastrophic Out-of-Pocket Health Expenditure Among Rural Households in the Semi-Pastoral Community, Western Ethiopia: A Community-Based Cross-Sectional Study. *Clinicoecon Outcomes Res* 2020;12:761–9.
26 World Health Organization. Global health observatory indicator views. 2022. Available: https://apps.who.int/gho/data/node.imr. FINPROTECTION_CATA_CTPFHU_40_HH?lang=en
27 Ahmadi F, Farrokh-Eslamlou H, Yusefzadeh H, *et al*. Incidence of household catastrophic and impoverishing health expenditures among patients with Breast Cancer in Iran. *BMC Health Serv Res* 2021;21:327.
28 Alinezhad F, Khalili F, Zare H, *et al*. Financial burden of prostate cancer in the Iranian population: a cost of illness and financial risk protection analysis. *Cost Eff Resour Alloc* 2023;21:84.
29 Zheng A, Duan W, Zhang L, *et al*. How great is current curative expenditure and catastrophic health expenditure among patients with cancer in China? A research based on "System of Health Account 2011". *Cancer Med* 2018;7:4036–43.
30 Azzani M, Yahya A, Roslani AC, *et al*. Catastrophic Health Expenditure Among Colorectal Cancer Patients and Families: A Case of Malaysia. *Asia Pac J Public Health* 2017;29:485–94.
31 Basavaiah G, Rent PD, Rent EG, *et al*. Financial Impact of Complex Cancer Surgery in India: A Study of Pancreatic Cancer. *J Glob Oncol* 2018;4:1–9.
32 Jane Bates M, Gordon MRP, Gordon SB, *et al*. Palliative care and catastrophic costs in Malawi after a diagnosis of advanced cancer: a prospective cohort study. *Lancet Glob Health* 2021;9:e1750–7.
33 Berlin NL, Albright BB, Moss HA, *et al*. Catastrophic health expenditures, insurance churn, and non-employment among women with breast cancer. *JNCI Cancer Spectr* 2024;8:pkae006.
34 Bhoo-Pathy N, Ng C-W, Lim GC-C, *et al*. Financial Toxicity After Cancer in a Setting With Universal Health Coverage: A Call for Urgent Action. *J Oncol Pract* 2019;15:e537–46.
35 Chauhan AS, Prinja S, Ghoshal S, *et al*. Economic Burden of Head and Neck Cancer Treatment in North India. *Asian Pac J Cancer Prev* 2019;20:403–9.
36 Choi J-W, Cho K-H, Choi Y, *et al*. Changes in economic status of households associated with catastrophic health expenditures for cancer in South Korea. *Asian Pac J Cancer Prev* 2014;15:2713–7.
37 Deng P, Fu Y, Chen M, *et al*. Factors associated with health care utilization and catastrophic health expenditure among cancer patients in China: Evidence from the China health and retirement longitudinal study. *Front Public Health* 2022;10:943271.

38 Fekri N, Parsaeian M, Pourreza A, *et al*. The Impact of Cancer Incidence on Catastrophic Health Expenditure in Iran with a Bayesian Spatio-Temporal Analysis. *Iran J Public Health* 2022;51:438–49.

39 Fu W, Shi J, Liu C, *et al*. Health insurance and inequalities in catastrophic health spending in cancer patients. A cross-sectional study in China. *Gac Sanit* 2024;38:102397.

40 ACTION Study Group, Kimman M, Jan S, *et al*. Catastrophic health expenditure and 12-month mortality associated with cancer in Southeast Asia: results from a longitudinal study in eight countries. *BMC Med* 2015;13:190.

41 group Cs. Catastrophic expenditure and treatment delivery outcomes in patients with colorectal cancer in India: a prospective, multicentre cohort study. *Lancet Oncol* 2022;23:S18.

42 Hoang VM, Pham CP, Vu QM, *et al*. Household Financial Burden and Poverty Impacts of Cancer Treatment in Vietnam. *Biomed Res Int* 2017;2017:9350147.

43 Kasahun GG, Gebretekle GB, Hailemichael Y, *et al*. Catastrophic healthcare expenditure and coping strategies among patients attending cancer treatment services in Addis Ababa, Ethiopia. *BMC Public Health* 2020;20:984.

44 Kavosi Z, Delavari H, Keshtkaran A, *et al*. Catastrophic health expenditures and coping strategies in households with cancer patients in Shiraz Namazi hospital. *Middle East J Cancer* 2014.

45 Leng A, Jing J, Nicholas S, *et al*. Catastrophic health expenditure of cancer patients at the end-of-life: a retrospective observational study in China. *BMC Palliat Care* 2019;18:43.

46 Liew CH, Shabaruddin FH, Dahlui M. The Burden of Out-of-Pocket Expenditure Related to Gynaecological Cancer in Malaysia. *Healthcare (Basel)* 2022;10:2099.

47 Matebie GY, Mebratie AD, Demeke T, *et al*. Catastrophic Health Expenditure and Associated Factors Among Hospitalized Cancer Patients in Addis Ababa, Ethiopia. *Risk Manag Healthc Policy* 2024;17:537–48.

48 Maurya PK, Murali S, Jayaseelan V, *et al*. Economic Burden of Cancer Treatment in a Region in South India: A Cross Sectional Analytical Study. *Asian Pac J Cancer Prev* 2021;22:89876:3755–62:.

49 Mohanty SK, Wadasadawala T, Sen S, *et al*. Catastrophic health expenditure and distress financing of breast cancer treatment in India: evidence from a longitudinal cohort study. *Int J Equity Health* 2024;23:145.

50 Piroozi B, Zarei B, Ghaderi B, *et al*. Catastrophic health expenditure and its determinants in households with gastrointestinal cancer patients: evidence from new health system reform in Iran. *IJHRH* 2019;12:249–57.

51 Prinja S, Dixit J, Gupta N, *et al*. Financial toxicity of cancer treatment in India: towards closing the cancer care gap. *Front Public Health* 2023;11:1065737.

52 Raman S, Shafie AA, Abraham MT, *et al*. Household Catastrophic Health Expenditure from Oral Potentially Malignant Disorders and Oral Cancer in Public Healthcare of Malaysia. *Asian Pac J Cancer Prev* 2022;23:90111:1611–8:.

53 Rezapour A, Norayi Motlagh S, Darvishi Teli B, *et al*. Understanding Household Catastrophic Health Expenditures and Fairness of Financing for Cancer Treatment: A Cross-sectional Case Study in West of Iran. *Health Scope* 2022;11.

54 Rice DR, Farooq A, Hyer JM, *et al*. Health expenditures and financial burden among patients with major gastrointestinal cancers relative to other common cancers in the United States. *Surgery* 2020;167:985–90.

55 Sui M, Zeng X, Tan WJ, *et al*. Catastrophic health expenditures of households living with pediatric leukemia in China. *Cancer Med* 2020;9:6802–12.

56 Sun C-Y, Shi J-F, Fu W-Q, *et al*. Catastrophic health expenditure and its determinants in households with lung cancer patients in China: a retrospective cohort study. *BMC Cancer* 2021;21:1323.

57 Sun C, Shi J, Fu W, *et al*. Catastrophic Health Expenditure and Its Determinants Among Households With Breast Cancer Patients in China: A Multicentre, Cross-Sectional Survey. *Front Public Health* 2021;9:704700.

58 Wan Puteh SE, Abdullah YR, Aizuddin AN. Catastrophic Health Expenditure (CHE) among Cancer Population in a Middle Income Country with Universal Healthcare Financing. *Asian Pac J Cancer Prev* 2023;24:90681:1897–904:.

59 Zarezadeh M, Ghafoori MH, Ghane M, *et al*. Catastrophic Health Expenditure and Its Determinants in Households with Pediatric Cancer and Oncology Disorders. *IJPHO* 2022.

60 Zhao S-W, Zhang X-Y, Dai W, *et al*. Effect of the catastrophic medical insurance on household catastrophic health expenditure: evidence from China. *Gac Sanit* 2020;34:370–6.

61 Doshmangir L, Hasanpoor E, Abou Jaoude GJ, *et al*. Incidence of Catastrophic Health Expenditure and Its Determinants in Cancer Patients: A Systematic Review and Meta-analysis. *Appl Health Econ Health Policy* 2021;19:839–55.

62 Andreyev HJN, Davidson SE, Gillespie C, *et al*. Practice guidance on the management of acute and chronic gastrointestinal problems arising as a result of treatment for cancer. *Gut* 2012;61:179–92.

63 Mukkamalla SKR, Recio-Boiles A, Babiker HM. *Gastric cancer*. 2017.

64 Lustberg MB, Kuderer NM, Desai A, *et al*. Mitigating long-term and delayed adverse events associated with cancer treatment: implications for survivorship. *Nat Rev Clin Oncol* 2023;20:527–42.

65 Wang J, Zhu H, Liu H, *et al*. Can the reform of integrating health insurance reduce inequity in catastrophic health expenditure? Evidence from China. *Int J Equity Health* 2020;19:49.

66 Williams GR, Mackenzie A, Magnuson A, *et al*. Comorbidity in older adults with cancer. *J Geriatr Oncol* 2016;7:249–57.

67 Mudaranthakam DP, Wick J, Calhoun E, *et al*. Financial burden among cancer patients: A national-level perspective. *Cancer Med* 2023;12:4638–46.

68 Torrini I, Lucifora C, Russo AG. The long-term effects of hospitalization on health care expenditures: An empirical analysis for the young-old population in Lombardy. *Health Policy* 2023;132.

69 Wills L, Nagarwalla D, Pearson C, *et al*. Estimating surgery, radiotherapy and systemic anti-cancer therapy treatment costs for cancer patients by stage at diagnosis. *Eur J Health Econ* 2024;25:763–74.

70 Raghupathi V, Raghupathi W. The influence of education on health: an empirical assessment of OECD countries for the period 1995-2015. *Arch Public Health* 2020;78:20.