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Financial toxicity in breast cancer patients during radiotherapy – A German multicenter analysis

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ABSTRACT

Introduction: Financial toxicity, defined as the financial burden and distress caused by cancer treatment, has emerged as a critical issue in oncology care. While most research originates from the U.S., data from countries with publicly funded healthcare systems remain limited, particularly regarding breast cancer patients receiving radiotherapy. This study investigates financial toxicity in radiation-treated breast cancer patients in the German healthcare system.

Methods: A retrospective, multicenter, cross-sectional study was conducted with 279 breast cancer patients from 11 certified German breast cancer centers. Data were collected via self-report questionnaires assessing financial distress, treatment-related costs, income loss, psychosocial distress, and global quality of life at the end of radiotherapy. Ordinal regression and moderation analyses were used to identify predictors and interactions. Group comparisons were performed using chi-square and Mann-Whitney U tests.

Results: 106 of 271 participants (39.1 %) reported financial toxicity, mostly at mild levels. Significant predictors included lower household income, higher direct treatment costs, and income loss. Income did not moderate the relationship between costs/income loss and financial toxicity. Patients with financial toxicity reported global lower quality of life and higher psychosocial distress. No differences were found by insurance and employment status, radiotherapy regimen, or concurrent systemic therapy.

Glossary: *EORTC QLQ-C30*: European organisation for research and treatment of cancer quality of life questionnaire-Core 30; *ESTRO:* European society for radiotherapy and oncology; *NCCN*: National comprehensive cancer network; *DEGRO*: German society for radiation oncology; *DIW*: German institute for economic research.

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Discussion and conclusion: Despite universal healthcare coverage and treatment in certified centers, a substantial proportion of breast cancer patients experienced financial toxicity. The findings suggest that socioeconomic consequences of treatment remain under-addressed in structured cancer care. Broader interventions are needed to mitigate financial distress in breast cancer patients undergoing radiation therapy.

1. Introduction

Breast cancer is the most diagnosed cancer among women worldwide, though men can be affected as well [1]. In 2022, an estimated 2.3 million new cases were reported globally [1]. Breast cancer is one of the leading causes of premature mortality among women, accounting for approximately 6.9 % of all cancer-related deaths [1]. In Germany, one in eight women is diagnosed with breast cancer at some point in her life [2]. In Europe, five-year survival rates vary by country but average around 83 %, reflecting advancements in early detection and treatment [3]. Nevertheless, these figures highlight the significant public health burden that breast cancer continues to pose both in Europe and globally.

Breast cancer patients face various burdens during treatment, including physical and emotional challenges. Among these, financial strain has gained increasing attention in recent years. Financial toxicity describes adverse financial effects from cancer diagnosis and treatment from a patient's perspective [4,5], including objective burdens like out-of-pocket expenses (e.g., costs for medications not covered by health insurance) and subjective distress from perceived financial threat.

Previous research has linked financial toxicity to a range of adverse outcomes, including lower overall survival rates [6,7], increased psychosocial distress [8–10], reduced health-related quality of life and decreased satisfaction with (breast) cancer care [7,11]. Low income and high levels of objective financial burden have also been identified as key contributing factors [12,13]. A recent meta-analysis estimated the prevalence of financial toxicity among breast cancer patients to be 35.3 % in high-income countries and 78.8 % in low- and middle-income countries [14]. These findings highlight the relevance of addressing financial toxicity in the context of breast cancer care.

Financial toxicity among breast cancer patients has been studied across various healthcare systems and treatment modalities, including, e.g., surgical interventions [15]. Initial research was primarily conducted in the context of the U.S. healthcare system, but more recently, several studies from publicly funded healthcare systems have also emerged [10,16,17]. However, research specifically focusing on radiotherapy remains limited. The German FinTox-study revealed financial toxicity in 41 % of patients undergoing radiotherapy in a cross-sectional study [18]. However, no cancer type-specific analyses were conducted. A recent study by Yusuf et al. investigated financial toxicity in breast cancer patients receiving radiotherapy in the United States [19]. Nevertheless, there is still a lack of studies specifically examining financial toxicity among breast cancer patients undergoing radiotherapy in publicly funded healthcare systems. Given that approximately 72 % of all German breast cancer patients receive radiotherapy [20], this highlights the importance of investigating financial toxicity during radiotherapy. Moreover, breast cancer patients represent a particularly relevant subgroup because they are often of working age at the time of diagnosis, have high long-term survival rates, and frequently receive multimodal treatment (surgery, radiotherapy, endocrine therapy, and in many cases chemotherapy). These factors may render the financial burden more pronounced and qualitatively different from other tumor entities such as lung or pancreatic cancer, where survival is shorter and treatment trajectories differ. To address this, the present study focuses exclusively on breast cancer patients who received radiotherapy in Germany, allowing for a more nuanced examination of financial toxicity experienced during treatment in a disease- and treatment-specific context within a universal health coverage setting. In Germany, statutory health insurance provides broad coverage for medical care, including cancer therapies and necessary travel related to treatment. During illness, wages are initially continued by the employer, after which patients are entitled to sickness benefits from their health insurance, amounting to a proportion of their salary. While this system offers substantial financial protection, certain non-essential items such as specific medical aids or care products are not reimbursed, which may still result in out-of-pocket expenses. These structural features are essential to consider when interpreting the prevalence of financial burden in the German context.

In the present study, we examined the prevalence of financial toxicity among breast cancer patients undergoing radiotherapy in radiation oncology centers and investigated factors that have been associated with its occurrence in previous research. Specifically, we assessed the impact of treatment-related costs and patient income, psychosocial stress, health-related quality of life, as well as dose fractionation/duration of and satisfaction with radiotherapy.

2. Methods

2.1. Procedure

The present retrospective, multicenter, cross-sectional study is based on data collected between June and August 2022. The data were derived from the prospective German FinTox study [18], which investigated financial toxicity across various cancer types and initially included 1075 participants (participation rate 46 %, 1075 of 2341 eligible patients; Fig. 1). As the present analysis represents a breast cancer–specific secondary analysis of this multicancer cohort, tumor-specific response rates are unfortunately not available. The study included German adult patients who, at the time of data collection, had been diagnosed with breast cancer and were at the end of their radiotherapy treatment (±2 days); thus, all questionnaires were completed immediately upon completion of active radiotherapy to ensure a uniform assessment point at the conclusion of active radiotherapy. Patients who did not have a primary diagnosis of breast cancer or received radiotherapy over < 15 treatment days were excluded from the present analysis. Furthermore, patients receiving palliative radiotherapy were excluded.

Data collection took place in radiation oncology centers at eleven locations (Freiburg, Hanover, Heidelberg, Bremen, Cologne, Dresden, Jena, Kiel, Hamburg, Munich, and Tuebingen) as part of the Young DEGRO Team Trial (German Society for Radiation Oncology). All participating centers were also certified German Breast Cancer Centers (certified by the German Society of Senology). The study was approved by the Ethics Committee of the Medical Faculty of the Christian-Albrechts-University of Kiel (reference number: D454/22), as well as by the ethics committees of all participating centers.

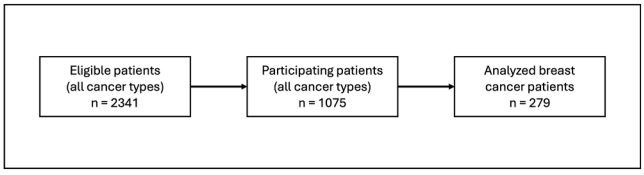

Fig. 1. Patient flow for the present analysis.
Note. Flow of patients from the FinTox cohort to the 279 breast cancer patients included in the present analysis.

2.2. Materials

We employed a paper-based, self-report questionnaire (Supplementary Document 1) to assess sociodemographic, disease-related, health-related, occupational, and financial variables. The questionnaire was developed by the study team based on a review of the literature and previously published studies on financial toxicity. Items were reviewed by radiation oncology and psycho-oncology experts and piloted for clarity before data collection.

We selected subjective financial distress as a surrogate measure for financial toxicity, as this construct closely aligns with the conceptualization of financial toxicity [4]. Furthermore, subjective financial distress has already been used as a surrogate measure in previous research [18, 21]. We assessed it using item 28 of the EORTC QLQ-C30 questionnaire ("During the past week: Has your physical condition or medical treatment caused you financial difficulties?") [22]. Participants rated the degree of financial distress on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much). Items of the EORTC QLQ-C30 were also utilized to assess quality of life (item 29, "How would you rate your overall quality of life during the past week?") and global health status (item 30, "How would you rate your overall health during the past week?"), both rated on a scale from 1 (very poor) to 7 (excellent) and analyzed in combination as recommended by the scale authors [22].

Objective financial burden was evaluated by assessing both direct and indirect costs associated with radiotherapy. To assess direct costs, participants provided information regarding the amount and specific causes of additional expenses incurred. Indirect costs were measured by estimating income loss.

Psychosocial distress was measured using the German version of the National Comprehensive Cancer Network (NCCN) Distress Thermometer [23], ranging from 0 to 10, with higher scores indicating greater psychosocial distress.

Additional measures included the duration of radiotherapy (in days) and whether participants received concurrent systemic therapy that is not related to radiation therapy or were partially or permanently hospitalized during radiotherapy. Satisfaction with radiotherapy was assessed using item 61 of the UK National Cancer Patient Experience Survey [24], which is rated on a scale from 1 to 10, with higher scores indicating greater satisfaction ("Overall, how would you rate your radiotherapy care?").

The collected descriptive variables included gender, age, marital status, years of education, employment status, type of health insurance, and net household income.

2.3. Statistical analyses

Data analysis was performed using RStudio (version 2025.05.0 + 496) and IBM SPSS Statistics (version 29.0.1). Descriptive statistics were computed to characterize the sample and assess the prevalence of key variables.

To examine predictors of subjective financial distress, an exploratory ordinal regression analysis was conducted. Prior to modeling, multicollinearity was assessed for all included variables (age, net household income, degree of income loss, duration of radiotherapy, self-employment status, and degree of direct costs) using the variance inflation factor (VIF), with all values < 2, indicating acceptable levels of collinearity.

Group differences in subjective financial distress between self-employed vs. non-self-employed participants, statutory vs. private insurance holders, those receiving concomitant systemic therapy vs. no systemic therapy, hypofractionated vs. conventionally fractionated radiotherapy regimens, and those satisfied vs. dissatisfied with radiotherapy were evaluated using chi-square tests. For this purpose, the variables financial distress and satisfaction with radiotherapy were dichotomized (yes/no). According to the Cancer Patient Experience Survey authors, a score > 8 is considered as satisfaction with radiotherapy [24]. To compare financial toxicity between groups with hypofractionated and conventionally fractionated radiotherapy regimens, the duration in treatment days was dichotomized. Cases < 15 treatment days (typically treatment of metastases) were excluded. Patients with 15 to 24 treatment days were classified as receiving hypofractionated radiotherapy, cases ≥ 25 treatment days as receiving conventionally fractionated radiotherapy.

Furthermore, a moderation analysis was conducted to assess whether net household income moderated the effects of direct costs and income loss on financial distress, given that the financial impact of these factors may vary depending on household income level.

To assess whether participants reporting financial distress had lower quality of life/global health status and higher values for psychosocial distress compared to those without financial distress, group comparisons were conducted. As the Shapiro-Wilk test indicated non-normal distributions for the variables (all p's < 0.001), non-parametric Mann-Whitney U tests were performed. Effect sizes were interpreted according to Cohen's (1992) recommendations ($r = 0.10$ small effect, $r = 0.30$ moderate effect, $r = 0.50$ large effect) [25].

Prior to the main analyses, the dataset was screened for missing values. The overall proportion of missing data was 3.0 % (186 out of 6138 values), with 2.9 % missing for the variable subjective financial distress (eight out of 279 cases). Cases with missing data were excluded listwise only from analyses involving the respective variables. For transparency, the exact sample size (n) is reported for each analysis in the Results.

A post-hoc power analysis using G*Power 3.1 [26] was conducted to evaluate the achieved power for the ordinal regression model. Assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, and 10 predictors, the analysis yielded a power > 0.999 with the actual sample size of $N = 279$.

2.4. Participants

The final sample consisted of 279 participants, predominantly female (98.9 %), with a mean age of 61.92 years (SD = 12.63; Min = 30; Max = 86). Sociodemographic, clinical, and financial characteristics, including marital status, educational level, health insurance, employment status, and net household income, are presented in Table 1.

Table 1
Sociodemographic, Clinical, and Financial Characteristics.

Variable	Category	n (%) / M (SD)
Age in years ($n = 279$)		61.92 (12.63)
Gender ($n = 279$)	Female	276 (98.9)
	Male	3 (1.1)
Marital status ($n = 278$)	Living alone	95 (34.2)
	Living with partner	183 (65.8)
Education ($n = 270$)	< 10 years	65 (24.1)
	10 years	108 (40.0)
	> 10 years	97 (35.9)
Health insurance ($n = 278$)	Public health insurance	231 (83.1)
	Private health insurance	47 (16.9)
Employment status ($n = 272$)	Employed	90 (33.1)
	Self-employed	17 (6.3)
	Civil servants	11 (4.0)
	Unemployed	26 (9.6)
	Retired	128 (47.1)
Net household income in Euro ($n = 247$)	< 1300	56 (22.7)
	1301–1700	47 (19.0)
	1701–2600	60 (24.3)
	2601–3600	41 (16.6)
	3601–5000	26 (10.5)
	> 5000	17 (6.9)

Note. Total $N = 279$. Sample sizes (n) vary due to missing data.

3. Results

The prevalence of financial distress was 39.1 % (106/271), defined as a response of at least 2 ("a little") on a 4-point Likert scale. Of these, 65.1 % ($n = 69$) reported a little, 25.5 % quite a bit ($n = 27$), and 9.4 % ($n = 10$) very much financial distress (see Fig. 2).

Objective financial burden due to direct costs was reported by 63.6 % ($n = 186/264$) of participants. The main causes were co-payments (73.2 %), transportation costs (77.4 %), and medications or care products (47.6 %). Indirect costs due to income losses were present in 31.1 % ($n = 85/273$) of the participants. For an overview of the degree of financial distress as well as the amount and causes of direct and indirect costs in the sample, see Table 2.

To investigate the predictors of financial distress, we conducted an ordinal regression analysis. The regression model significantly improved model fit compared to the null model, as indicated by the Likelihood-Ratio Test ($\chi^2(6) = 77.86$, $p < 0.001$). The McFadden Pseudo-R^2 of 0.39 further supports the adequacy of the model [27]. Significant predictors of subjective financial distress included net household income (OR = 0.638, 95 % CI [0.509–0.800], $p < 0.001$), degree of direct costs (OR = 1.847, 95 % CI [1.313–2.598], $p < 0.001$), and degree of income loss (OR = 2.262, 95 % CI [1.657–3.089], $p < 0.001$). These findings suggest that higher net household income is associated with lower financial distress, while higher direct costs and income loss increase the likelihood of experiencing financial distress. Age, duration of radiotherapy, and self-employment status were not significant predictors (all p's > 0.05). For an overview of the regression results, see Table 3.

We tested whether net household income moderates the effects of direct costs and income loss on financial distress. Neither the interaction between direct costs and net household income ($\beta = -0.200$, SE = 0.107, $p = 0.062$; $n = 218$) nor the interaction between income loss and net household income ($\beta = -0.145$, SE = 0.078, $p = 0.063$) was significant.

Group comparisons showed no significant differences in financial distress by employment status (self-employed vs. others; $\chi^2(1) = 0.38$, $p = 0.54$, $n = 271$), health insurance type (statutory vs. private; $\chi^2(1) = 3.59$, $p = 0.06$, $n = 270$), systemic therapy status ($\chi^2(1) = 0.011$, $p = 0.91$, $n = 268$) fractionation (hypofractionated vs. conventionally fractionated; $\chi^2(1) = 2.816$, $p = 0.09$, $n = 245$), or satisfaction with radiotherapy ($\chi^2(1) = 1.915$, $p = 0.166$, $n = 266$).

Participants reporting financial distress had significantly lower quality of life/global health status (Mdn = 50.0) than those without distress (Mdn = 58.3; $U = 6164.0$, $p < 0.001$, $r = 0.24$). Psychosocial distress was significantly higher in the financial distress group (Mdn = 6 vs. 4; $U = 6006.0$, $p < 0.001$, $r = 0.27$). All effects showed small to medium effect sizes [25].

The mean number of radiotherapy treatments was 21.36 (SD = 7.68). During treatment, 16 % (44/275) received concurrent systemic therapy without direct relation to the radiotherapy. Only a few patients were hospitalized during radiotherapy (1.8 % during the whole course, 3.6 % partially). 89.4 % (244/273) reported satisfaction with radiotherapy ($M = 9.02$, SD = 1.41).

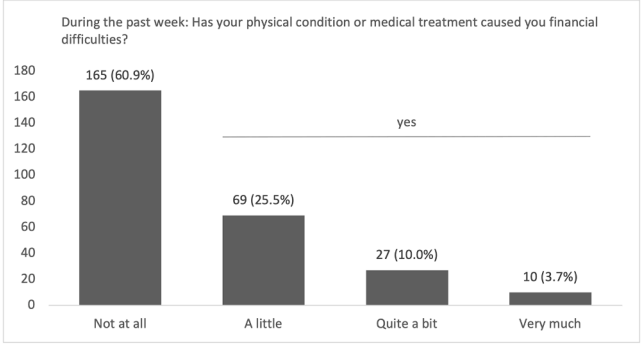

Fig. 2. Reported Financial distress (item 28 of the EORTC QLQ-C30 questionnaire).
Note. $N = 271$.

Table 2
Financial distress and direct/indirect costs.

Variable	Category	n (%)
Financial distress ($n = 271$)	Not at all	165 (60.9)
	A little	69 (25.5)
	Quite a bit	27 (10.0)
	Very much	10 (3.7)
Degree of direct costs in Euro ($n = 137$)	< 100	39 (28.5)
	101–500	91 (66.4)
	501–1500	7 (5.1)
Causes of direct costs ($n = 168$)	Co-payments	123 (73.2)
	Travel expenses	130 (77.4)
	Medications/care products	80 (47.6)
	Other	8 (4.8)
Degree of income loss in Euro ($n = 72$)	< 100	6 (8.3)
	101–500	42 (58.3)
	501–1500	19 (26.4)
	1501–2500	4 (5.6)
	> 2500	1 (1.4)

Note. Total $N = 279$. Sample sizes (n) vary due to missing data or missing costs/income loss.

4. Discussion

The present study investigated the prevalence and predictors of financial toxicity among breast cancer patients undergoing radiotherapy in Germany, within a publicly funded healthcare system. Our findings show that despite universal health coverage, a substantial proportion of patients (39.1 %) reported experiencing financial toxicity during radiotherapy. Consistent with previous findings, financial toxicity was significantly associated with lower income, higher direct costs, and greater income loss [9–13]. Additionally, patients reporting financial toxicity had poorer quality of life/global health status, and higher psychosocial distress compared to those without financial toxicity [7,11]. Patient satisfaction with radiotherapy was high.

Despite the high prevalence in this sample, most affected patients reported only a mild degree of financial toxicity (65.1 %), highlighting the burden of cancer treatment even within a publicly funded healthcare system. To contextualize, we compared the observed prevalence of financial toxicity in breast cancer patients with published prevalence rates for other tumor entities. Previous research has reported a prevalence of approximately 41 % across various cancer types [18], which is comparable to the rate found in the present breast cancer sample. This suggests that financial toxicity is a common challenge across different cancer types receiving structured treatment, rather than being unique to breast cancer. While certified centers provide coordinated and high-quality oncological care—an approach applied across multiple tumor types—the persistence of financial toxicity highlights a broader issue: structured cancer care possibly often prioritizes clinical outcomes, such as survival and disease control, with less emphasis on addressing the socioeconomic consequences of treatment. This interpretation aligns with findings from Schmitt et al. (2023), who demonstrated that treatment in certified centers improves overall survival across tumor types [28], yet our data indicate that improved clinical care does not necessarily translate into reduced financial burden. Moreover, the prevalence of financial toxicity in our sample was slightly higher than the 35.3 % reported among breast cancer patients in high-income countries in a 2023 meta-analysis by Ehsan et al. [14]. However, comparing prevalence across healthcare systems remains challenging due to differences in system structures and funding mechanisms. In addition, potential differences within Europe should be considered, as reimbursement policies, co-payment regulations, and access to social support services

Table 3
Ordinal regression analysis.

Variable	β	SE	z	p	Wald's χ^2	OR	95 %-CI
Age	−0.003	0.014	−0.24	0.813	0.06	0.997	0.970–1.024
Net household income	−0.449	0.116	−3.89	<0.001*	15.13	0.638	0.509–0.800
Degree of income loss	0.816	0.159	5.14	<0.001*	26.42	2.262	1.657–3.089
Degree of direct costs	0.614	0.174	3.52	<0.001*	12.39	1.847	1.313–2.598
Duration of radiotherapy[1]	−0.021	0.021	−1.00	0.320	1.00	0.979	0.940–1.020
Self-employment	−0.084	0.717	0.12	0.907	0.02	0.920	0.226–3.750

Note. $N = 206$. Dependent variable = Subjective financial distress. McFadden Pseudo-$R^2 = 0.39$.
* $p \leq 0.01$.
[1] Continuous variable.

vary substantially between countries. Such systemic differences do not merely represent administrative variation but directly influence whether and to what extent patients face out-of-pocket costs, income loss, or barriers to support. Emphasizing this context is therefore essential for a meaningful interpretation of prevalence estimates across health care settings. Such heterogeneity may contribute to variations in the prevalence and severity of financial toxicity across settings, even within high-income regions.

In our data, income level significantly influenced the likelihood of experiencing financial toxicity: lower income was associated with a higher risk. Similarly, greater treatment-related costs and more substantial income losses also increased the probability of financial toxicity. However, income did not function as a moderator—its effect did not buffer or amplify the relationship between financial toxicity and treatment-related costs or income losses. Thus, even higher-income patients may experience financial toxicity when faced with high out-of-pocket expenses and income reductions during treatment. This income-independent effect is also reflected in the lack of significant differences between privately and statutorily insured patients in our sample. According to a consistent study by the German Institute for Economic Research (DIW), even individuals with considerable financial assets are not immune to financial concerns [29]

There was no observed significant difference in financial toxicity between patients treated with hypofractionated versus conventionally fractionated radiotherapy. This finding aligns with previous clinical trials on hypofractionation, which reported similar outcomes in terms of somatic toxicity [30,31]. This suggests that financial burden is not primarily determined by the radiotherapy regimen or its duration, but rather by the overall economic impact of cancer. In line with this, it must be emphasized that financial toxicity in breast cancer care is not necessarily attributable to radiotherapy alone but may also arise from diagnostics, surgery, or systemic therapies such as chemotherapy and endocrine treatment, which were not assessed in our dataset. The use of neoadjuvant or adjuvant chemotherapy over the course of several months, which was not assessed here, is included. In line with this, earlier studies have found no significant difference in quality of life between breast cancer patients with and without radiotherapy [32]. Our findings therefore contribute to the ongoing debate on the optimal fractionation regimen, suggesting that shorter regimens such as hypofractionation may not provide measurable financial relief for patients in the German healthcare setting. From a system perspective, hypofractionation is expected to reduce costs for health insurance providers, as reimbursement is typically based on the number of fractions delivered. However, for patients themselves, the frequency of visits to the radiotherapy department did not translate into a relevant difference in financial toxicity in our study. This supports the interpretation that hypofractionation is not inferior to normofractionation with respect to patient-reported financial burden. Whether ultrahypofractionation, as investigated in the Fast-Forward trial presented at the European Society for Radiotherapy and Oncology (ESTRO), might offer additional advantages remains uncertain and cannot be clarified by our data.

Some limitations of this study should be considered. Financial toxicity was assessed using a single, validated item from the EORTC QLQ-C30. While widely accepted, this item captures financial burden only in broad terms and does not differentiate between various dimensions of financial toxicity. Moreover, we used a self-developed questionnaire to assess additional financial variables. Although this instrument was piloted and reviewed by experts [33], it has not undergone formal psychometric validation, which limits comparability with international studies using standardized tools, and reduces the generalizability and validity of our findings. We also lacked data on household size, financial situation prior to diagnosis, or access to social and legal support services—all of which may influence financial toxicity. Moreover, all data were self-reported, which may be subject to recall or social desirability bias. In addition, the voluntary nature of study participation may have introduced selection bias, as patients who agreed to participate could differ systematically from non-participants in terms of socioeconomic background, health status, or treatment experiences. Furthermore, because the present analysis is based on a multicancer cohort, we were unable to calculate a breast cancer–specific response rate, which restricts the assessment of potential selection bias specific to breast cancer patients.

In addition, breast cancer–specific clinical data such as systemic treatments, indication for radiotherapy, target volumes, boost application, or type of surgery were not available in our dataset and therefore could not be included in the analyses. This may limit the interpretation of our findings. However, while adjuvant systemic therapies such as endocrine treatment or chemotherapy are well known to affect health-related quality of life and financial distress, technical details of radiotherapy such as boost application or target volume size are unlikely to be perceived directly by patients and thus may play only a minor role in shaping subjective financial burden.

Due to our cross-sectional study design and the lack of baseline data or a control group, we cannot determine whether the observed reductions in quality of life and increased psychosocial burden are causally related to radiotherapy, nor can we rule out that financial toxicity was already present prior to treatment initiation. Moreover, as financial toxicity was assessed only once at the end of radiotherapy (± 2 days), this acute time point may not fully reflect the broader and longer-term financial consequences of treatment. Longitudinal studies are therefore necessary to isolate the specific contribution of radiotherapy to financial and psychological burden and to differentiate it from other treatment-related or social stressors. Future studies should investigate the origins and trajectories of financial burden to inform targeted interventions such as financial counseling, improved access to social services, and policy reforms. Since patients with < 15 radiotherapy treatments were excluded, this finding cannot be extrapolated to ultra-hypofractionated partial- or whole-breast radiotherapy.

In summary, our study shows that even within a universal healthcare system like Germany's, a substantial proportion of breast cancer patients undergoing radiotherapy experience financial toxicity. Key predictors include low income, direct treatment costs, and income loss. Financial toxicity was also associated with reduced quality of life/global health status and increased psychosocial distress. The persistence of financial distress despite structured, high-quality care settings indicates that financial toxicity is a multidimensional problem requiring broader

solutions beyond clinical quality initiatives.

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Ethics approval

The study was approved by the Ethics Committee of the Medical Faculty of the Christian-Albrechts-University of Kiel (reference number: D454/22), as well as by the ethics committees of all participating centers.

CRediT authorship contribution statement

Bjarn-Ove Tetzlaff: Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Alexander Rühle:** Writing – review & editing, Project administration, Investigation, Conceptualization. **Justus Domschikowski:** Writing – review & editing, Investigation. **Maike Trommer:** Writing – review & editing, Investigation. **Simone Ferdinandus:** Writing – review & editing, Investigation. **Jan-Niklas Becker:** Writing – review & editing, Investigation. **Georg Wurschi:** Writing – review & editing, Investigation. **Simon Böke:** Writing – review & editing, Investigation. **Christoph A. Grott:** Writing – review & editing, Investigation. **Lukas Käsmann:** Writing – review & editing, Investigation. **Melanie Schneider:** Writing – review & editing, Investigation. **Elodie Bockelmann:** Writing – review & editing, Investigation. **David Krug:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Nils H. Nicolay:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Alexander Fabian:** Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mathias Sonnhoff:** Writing – review & editing, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Simon Böke has received honoraria from Elekta AB and Merck KGaA. David Krug has received honoraria from AstraZeneca, Best Practice Onkologie, ESO, ESMO, Gilead, Med Update, Merck Sharp & Dohme, Novartis, Onkowissen, and Pfizer; has served on advisory boards for Gilead; and has received institutional research funding from Stiftung Deutsche Krebshilfe and Merck KGaA. All other authors declare no relevant conflicts of interest.

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The study was conducted as a joint research project of the young DEGRO Trial Group and was scientifically supervised by the group.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ctarc.2025.101071.

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