

ORIGINAL ARTICLE

Health-related quality of life supersedes other psychosocial predictors of long-term survival in cancer patients undergoing radiotherapy

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Abstract

Background. To investigate the prognostic value of several psychosocial factors for long-term survival in cancer patients. **Material and methods.** Baseline data were gathered in routine radiotherapy practice during 44 months. The analysis is based on 938 patients for whom follow-up data were available. Baseline psychosocial distress, depression, health-related quality of life (HRQOL), and life satisfaction were assessed using Questionnaire on Stress in Cancer Patients (QSC-R23), Self-Rating Depression Scale (SDS), Functional Assessment of Therapy – General (FACT-G) questionnaire, and Questions on Life Satisfaction (FLZ^M). Patients were followed up for 7 to 10 years. Kaplan-Meier plots and Cox proportional hazards models were used to investigate associations between sociodemographic, clinical, psychosocial factors and overall survival (OS). **Results.** Patients' median survival time was 35 months (95% CI 28.9–41.1). Significant multivariate predictors of OS were age, health insurance type, Karnofsky performance status, cancer site, and cancer stage. Controlling for these variables, HRQOL was the only psychosocial predictor of survival (hazard ratio 0.988, 95% CI 0.979–0.997, $p = 0.009$). The physical well-being and the functional well-being subscales of the FACT-G emerged as the relevant HRQOL facets predictive of survival. **Conclusion.** HRQOL has incremental predictive value for long-term survival in cancer patients.

Clinical and treatment-related variables are potent predictors of mortality after cancer [1]. Besides medical variables, sociodemographic characteristics like low educational level [2] or living unpartnered [3] proved to be associated with survival.

Furthermore, numerous psychosocial characteristics were assessed for their potential to predict cancer survival. Petticrew et al. [4] concluded that there is no convincing evidence that coping is predictive of survival. With regard to depression, there is meta-analytic evidence for a relatively weak but robust effect on cancer survival [5]. Actually, the most consistent effect is reported for health-related quality of life (HRQOL) [6,7].

Besides, the recent years witnessed an increased interest in positive psychological characteristics and their role for survival. Chida and Steptoe [8] concluded that positive affect and positive trait-like dispositions,

e.g. sense of humor or life satisfaction, were associated with reduced mortality in healthy populations and in some disease populations. Indeed, one study with breast cancer patients found that life satisfaction predicted survival controlling for the effect of cancer stage at presentation [9].

Most of those studies investigated the predictive effect of one psychosocial factor at one time, although there are some studies that did include multiple psychosocial predictors. While some of these studies found more or less support for the impact of one or even several psychosocial factors on survival [10–13], others did not [14,15]. Although most of these studies realized long-term follow-up assessments up to 10 years and more, the sample size was comparatively low (< 400 in four of the six cited studies), and there was a strong preponderance of breast cancer patients. Importantly, only one study used a multi-dimensional

measure of HRQOL [14], two further studies employed single item quality of life measures [10,12]. Interestingly, none of these three studies found support for a role of HRQOL in cancer survival.

Therefore, the aim of the current analysis is to investigate the prognostic value of multiple psychosocial variables for long-term survival in a large cancer sample. Specifically, we aim to uncover which of the psychosocial variables included provides incremental predictive value, controlling for sociodemographic and clinical variables.

Material and methods

Study procedure

This study was conducted in the Department of Radiotherapy and Radiooncology of a large German university hospital. Patients were included between 1997 and 2001 (44 months). Apart from a sociodemographic sheet, the patients completed self-administered questionnaires assessing cancer-specific psychosocial distress, depression, HRQOL, life satisfaction, coping, and social support. With the inclusion of several psychosocial variables, there is the possibility of harmful multicollinearity. To minimize the risk of multicollinearity and chance findings, we decided not to include all of our measures. We did not include our coping measure, as there is only very weak empirical evidence for a role of coping in cancer survival [4]. Furthermore, we refrained from including the social support measure, as this scale had not been convincingly validated in German.

Patients were assessed at the beginning, i.e. within the first three days, and at the end of radiation therapy. Follow-up assessments were conducted after six weeks, six months, one year, two years, and at the end of the study, i.e. 7 to about 10 years after the end of radiation therapy. Maximum follow-up was 129 months. This study was carried out in routine clinical practice. Patients were informed about the study and were asked to provide written informed consent. Assessment before and after radiotherapy was conducted during a personal appointment, the follow-up assessments were conducted by mail. Clinical variables were extracted from patient medical records. Functional status, i.e. Karnofsky performance status (KPS) [16], was assessed by the research assistants. Patient's death was determined by using data from the tumor registry Munich. In some cases, the patient's general practitioner was asked, or postal questionnaires were returned with the information that the recipient had passed. Ethical approval for this study was obtained from the local ethics committee before the start of the investigation.

Study sample

Patients who had a malignant tumor and were going to be treated by radiation therapy were approached for study participation. Further inclusion criteria were minimum age of 18 years and KPS \geq 50. Exclusion criteria were cognitive impairment and insufficient knowledge of the German language. During the inclusion period, N = 2170 patients were eligible. Two hundred and sixty-one were excluded as they met exclusion criteria. Furthermore, 33 patients died shortly before baseline assessment, and 79 patients did not provide baseline data in time but participated in the following assessments. Of the remaining patients, 270 were not included due to organizational problems relating to routine clinical practice, leaving 1527 patients who were actually available for study participation. However, 439 of them refused to participate and thus, the study sample comprises 1088 patients (71.3%).

The patients who declined participation were older ($M = 61.7$, $SD = 12.9$ vs. $M = 57.7$, $SD = 13.6$; $p < 0.001$), and the rate of patients with statutory health insurance (SHI) was higher among the declining patients (72.3% vs. 62.1%; $p < 0.001$). The rate of patients with medium performance status was higher in the declining group (19.2% vs. 15.6%; $p < 0.01$). Finally, cancer site had an effect, i.e. the rate of patients with gastrointestinal tumor was higher among those who refused to participate (27.4% vs. 19.7%; $p < 0.01$). There were no differences regarding sex and disease stage (early vs. advanced) among the study sample and those patients not consenting.

Measures

Cancer-specific psychosocial distress was assessed with the Questionnaire on Stress in Cancer Patients (QSC). At the beginning of the study, a preliminary version was available which included the 23 items that later formed the revised QSC-R23 [17]. The items pertain to stressful experiences in daily life. The response categories range between 0 (the problem does not apply to me) and 5 (the problem applies to me and is a very serious problem). In the current analysis, the summary score was used. The QSC-R23 has proven a reliable and valid measure.

We used the well-known Self-Rating Depression Scale (SDS) to assess symptoms of depression [18]. It contains 20 items which are rated from 1 to 4, with higher numbers indicating a more unfavorable response. Participants indicated how they felt during the week preceding.

Patients' HRQOL was measured using the widely used multidimensional questionnaire Functional Assessment of Cancer Therapy – General (FACT-G)

[19]. We applied version 3 of the FACT-G, which comprises 29 items pertaining to well-being during the past week. The items are rated on a five-point scale ranging from 0 to 4. They belong to the five subscales physical well-being, social/family well-being, emotional well-being, functional well-being, and relationship with physician, yielding a total score range of 0–116. Higher scores indicate a more favorable response.

Life satisfaction was measured with the Questions on Life Satisfaction (FLZ^M) [20]. This reliable and valid German measure contains two modules, general life satisfaction and satisfaction with health. Only the general life satisfaction module, which covers eight areas of life usually judged important in Western culture, was used here. Participants indicated their degree of satisfaction during the past four weeks. Each item is weighted with an importance rating. Increasing scores indicate higher life satisfaction.

Statistical analysis

Descriptive statistics were computed for demographic and clinical data and the psychosocial variables. Overall survival (OS) was the primary end point in this analysis. OS was calculated from the day of first radiotherapy fraction until death from any cause. Patients alive at last follow-up were censored. Median survival time and five-year survival rates were estimated using the Kaplan-Meier method. The log-rank test was applied to estimate the statistical significance of differences between patient groups. Univariate and multivariate analyses were performed using Cox proportional hazards regression modeling. The proportionality assumption was verified by graphical inspection. The relevance of a prognostic factor was assessed by Wald test statistics, the hazard ratio (HR), and its 95% confidence interval (CI). All statistical tests were two-sided. The analyses were performed using SPSS/PC software package version 18.0.

Factors included in these analyses were age, sex, relationship status (with partner vs. single), educational level (lower: up to 9 years, medium: 10–12 years, high: more than 12 years), insurance status (statutory vs. private), KPS (low: 50–59, medium: 60–79, high: 80–100), disease stage (early, advanced, unknown), cancer site, QSC-R23 total score, SDS total score, FACT-G total score, and FLZ^M-general life satisfaction score. The four psychosocial variables were included as continuous measures in the Cox regression models and were categorized for the Kaplan-Meier analysis. We used established cut off-scores to categorize QSC-R23 mean score (> 1.5) and SDS summary score (> 49). Categorization of the FACT-G and the FLZ^M score was based on terciles, as there are no established clinical cut off-scores.

Results

Patient demographic and clinical characteristics are summarized in Table I. We excluded 150 patients from the further analyses due to missing data (no survival data or no data for one of the psychosocial variables). A final overview of patients' flow through the study is given in Figure 1. The excluded patients did not differ from the remaining 938 patients with regard to age, sex, educational level, insurance status, cancer site, disease stage, and performance status. However, the final sample comprised a higher percentage of patients living with a partner (70.9% participating group vs. 58.5% excluded group, $p = 0.002$) and a higher percentage of patients with high performance status (82.8% participating group vs. 72.7% excluded group, $p = 0.012$).

The median follow-up of the living patients was 106 months. The median survival time was 35 months (95% CI 28.9–41.1), and the five-year survival rate

Table I. Sociodemographic and clinical characteristics of the study sample (N = 1088).

	n	M (SD)	%
Age		57.7 (13.6)	
≤ 49	267		24.5
50–59	296		27.2
60–69	314		28.9
≥ 70	211		19.4
Sex			
Female	469		43.1
Male	619		56.9
Partnership			
Single	335		30.8
Living with partner	753		69.2
Educational level			
Low	466		43.2
Medium	295		27.3
High	318		29.5
Health insurance			
Statutory	674		62.1
Private	411		37.9
KPS			
Low	32		2.9
Medium	170		15.6
High	886		81.4
Cancer site			
Breast	176		16.2
Gastrointestinal	214		19.7
Head / neck	158		14.5
Lung	108		9.9
Lymphoma	130		11.9
Urogenital	127		11.7
Other	175		16.1
Cancer stage			
Early	467		42.9
Advanced	591		54.3
Unknown	30		2.8

KPS, Karnofsky performance status.

Data may not sum to full sample size or 100% due to missing data or rounding error.

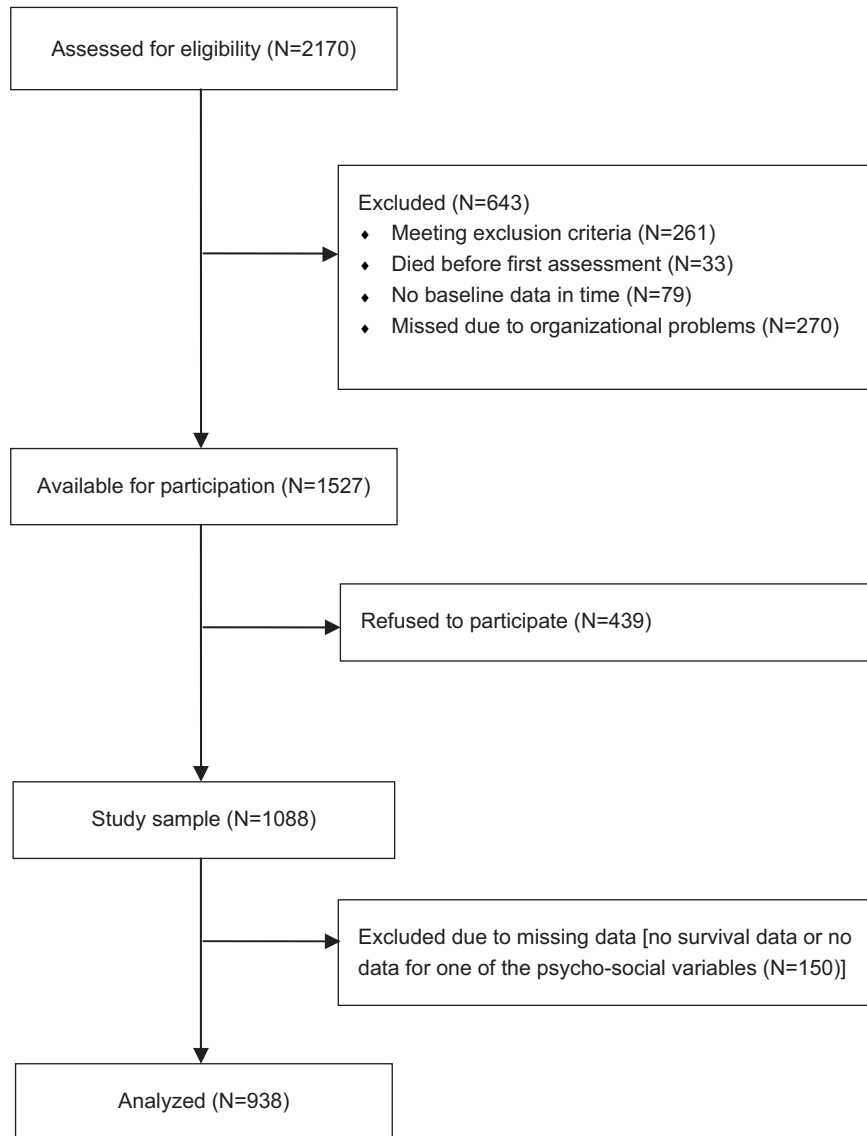


Figure 1. Patients' flow through the study.

was 0.41 (SE 0.02). At study termination, 615 of the patients were deceased, and 323 were censored.

Intercorrelations

In Table II, we present the intercorrelations among the psychosocial variables, along with descriptives for each variable. All of the variables are moderately to highly intercorrelated, showing a meaningful pattern of associations. All bivariate correlations were below $r = 0.80$ and only two exceeded $r = 0.70$, indicating that multicollinearity should not be a major obstacle for further analyses.

Univariate analysis

As shown in Table III, younger age, being female, medium educational level, private health insurance,

higher functional status, and early disease stage were predictive of longer median survival time. Lung cancer had the lowest five-year survival rate, while breast

Table II. Intercorrelations, mean (M), standard deviation (SD) and internal consistency (α) for the psychosocial variables (N = 938).

	QSC-R23	SDS	FACT-G	FLZ ^M
QSC-R23	–	0.64	–0.73	–0.38
SDS		–	–0.77	–0.41
FACT-G			–	0.49
M	1.35	47.94	80.32	48.24
SD	0.83	11.15	16.21	30.90
α	0.89	0.84	0.89	0.67

FACT-G, Functional Assessment of Cancer Therapy-General; FLZ^M, Questions on Life Satisfaction; QSC-R23, Questionnaire on Stress in Cancer Patients; SDS, Self-Rating Depression Scale. All correlations are significant at $p < 0.001$.

Table III. Results of the Kaplan-Meier analysis and the log-rank test for comparison of estimators between patient groups (N = 938).

	n	5-year survival rate	median survival (months)	95% CI	p
Sociodemographic variables					
Age					<0.001
≤ 49	231	0.535	109	76–142	
50–59	267	0.418	33	21–45	
60–69	273	0.395	34	25–43	
≥ 70	167	0.250	22	17–27	
Sex					<0.001
Female	398	0.493	58	33–83	
Male	540	0.350	30	27–34	
Partnership					0.994
Single	273	0.401	33	22–44	
With partner	665	0.414	35	28–42	
Educational level					0.029
Low	403	0.371	30	22–38	
Medium	259	0.478	53	27–79	
High	276	0.404	35	29–41	
Health insurance					0.022
Statutory	578	0.384	32	25–39	
Private	360	0.452	44	31–57	
Clinical variables					
KPS					<0.001
Low	25	0.120	12	1–23	
Medium	136	0.182	10	8–12	
High	777	0.459	48	38–58	
Cancer site					<0.001
Breast	160	0.674	n.a.	n.a.	
Gastrointestinal	184	0.286	24	17–31	
Head / neck	132	0.340	28	18–38	
Lung	93	0.108	11	8–14	
Lymphoma	117	0.650	n.a.	n.a.	
Urogenital	107	0.495	60	12–108	
Other	145	0.279	20	15–25	
Cancer stage					<0.001
Early	406	0.620	125	n.a.	
Advanced	505	0.242	18	15–21	
Unknown	27	0.407	40	20–60	
Psychosocial variables					
QSC-R23					<0.001
Normal range	592	0.452	44	34–54	
Elevated	346	0.339	26	20–32	
SDS					<0.001
Normal range	534	0.497	60	41–79	
Elevated	404	0.295	21	17–25	
FACT-G					<0.001
Low	304	0.298	20	15–25	
Medium	317	0.415	35	25–45	
High	317	0.513	68	33–103	
FLZ ^M					0.002
Low	314	0.342	30	24–36	
Medium	316	0.411	35	24–46	
High	308	0.479	53	36–70	

CI, confidence interval; FACT-G, Functional Assessment of Cancer Therapy-General; FLZ^M, Questions on Life Satisfaction; KPS, Karnofsky performance status; QSC-R23, Questionnaire on Stress in Cancer Patients-Revised; SDS, Self-Rating Depression Scale.

Median survival time and associated CI could not be computed for breast cancer and lymphoma as well as cancer stage. As the event (i.e. death) occurred in less than 50% of cases in these groups, Kaplan-Meier-analysis does not provide an estimate for median survival time.

Categorization of QSC-R23 and SDS is based on established cut-off scores; higher scores indicate clinical level of distress. Categorization of FACT-G and FLZ^M scores is based on terciles; higher scores indicate better functioning and satisfaction, respectively.

Table IV. Results of the univariate and multivariate Cox proportional hazards models (N = 938).

	univariate			multivariate		
	HR	95% CI	p	HR	95% CI	p
Age	1.022	1.015–1.028	<0.001	1.015	1.008–1.023	<0.001
Sex			<0.001			0.274
Female	0.701	0.595–0.825		0.893	0.730–1.094	
Male	1			1		
Partnership			0.994			0.609
Single	0.999	0.839–1.190		1.050	0.871–1.265	
With partner	1			1		
Educational level			0.031			0.084
Low	1.122	0.930–1.353	0.228	0.798	0.650–0.980	0.032
Medium	0.862	0.694–1.069	0.176	0.826	0.658–1.036	0.099
High	1			1		
Health insurance			0.023			0.008
Private	0.826	0.701–0.974		0.785	0.656–0.940	
Statutory	1			1		
KPS			<0.001			<0.001
Low	1	0.600–1.462	0.772	1	0.542–1.365	0.523
Medium	0.936	0.234–0.543	<0.001	0.860	0.300–0.726	0.001
High	0.357			0.467		
Cancer site			<0.001			<0.001
Breast	0.344	0.253–0.467	<0.001	0.430	0.313–0.591	<0.001
Gastrointestinal	1.007	0.786–1.290	0.957	0.732	0.557–0.962	0.025
Head/neck	0.862	0.656–1.132	0.286	0.800	0.598–1.070	0.132
Lung	1.834	1.384–2.429	<0.001	1.497	1.107–2.024	0.009
Lymphoma	0.343	0.243–0.483	<0.001	0.377	0.264–0.537	<0.001
Urogenital	0.547	0.399–0.749	<0.001	0.497	0.352–0.701	<0.001
Other	1			1		
Cancer stage			<0.001			<0.001
Early	0.330	0.277–0.394	<0.001	0.400	0.332–0.482	<0.001
Advanced	1			1		
Unknown	0.604	0.377–0.969	0.036	0.801	0.489–1.329	0.391
QSC-R23	1.248	1.138–1.369	<0.001	0.962	0.834–1.110	0.600
SDS	1.029	1.022–1.036	<0.001	1.010	0.999–1.022	0.081
FACT-G	0.983	0.978–0.987	<0.001	0.988	0.979–0.997	0.009
FLZ ^M	0.996	0.993–0.998	0.001	1.001	0.998–1.004	0.703

CI, confidence interval; FACT-G, Functional Assessment of Cancer Therapy-General; FLZ^M, Questions on Life Satisfaction; HR, hazard ratio; KPS, Karnofsky performance status; QSC-R23, Questionnaire on Stress in Cancer Patients-Revised; SDS, Self-Rating Depression Scale.

QSC-R23, SDS, FACT-G, and FLZ^Z scores were entered into the regression as continuous variables. In the multivariate analysis, each HR is adjusted simultaneously for all the other variables shown in the table. HRs greater than 1.00 represent an increased risk of death from any cause.

cancer and lymphoma had the highest. Moreover, all of the psychosocial variables were significantly associated with survival. The hazard ratio for each prognostic factor is shown in Table IV. Of the variables considered for univariate Cox regression models, only partnership status failed to predict OS.

Multivariate analysis

The results of the multivariate Cox proportional hazards model are shown in Table IV. Though significant in the univariate analysis, sex and educational level did not predict OS when considered simultaneously with all other variables. Age, health insurance status, KPS, cancer site and stage of disease were prognostic for OS. Controlling for the effects of these variables, HRQOL was the only psychosocial variable

predictive of survival with an HR of 0.988 (95% CI 0.979–0.997, $p = 0.009$).

As a complementary analysis, we investigated whether HRQOL differs depending on sociodemographic and clinical variables. Men ($p < 0.05$), patients living with a partner ($p < 0.01$), patients with early disease stage ($p < 0.01$) and with higher KPS ($p < 0.001$) reported higher HRQOL. Furthermore, cancer site had an effect, i.e. patients with urogenital cancer reported the highest and lung cancer patients reported the lowest HRQOL ($p < 0.05$). Age, educational level, and health insurance type did not impact HRQOL.

Additional subscale analysis

To further elucidate which facet of HRQOL was the most important one in predicting OS, we repeated

our multivariate analysis applying the FACT-G subscales. Nine hundred and thirty patients had provided sufficient data to compute subscale scores. The intercorrelation matrix of the five subscales revealed that multicollinearity should not be of importance for this analysis (Table V). The results of the multivariate Cox proportional hazards model show that physical well-being (PWB) and functional well-being (FWB) were significantly associated with survival (Table VI).

Adjusted cumulative survival rates based on FACT-G PWB and FWB subscale score, both categorized in three groups for descriptive purposes, are shown in Figure 2a and b to illustrate the association with survival.

Discussion

Our results showed that HRQOL supersedes other psychosocial predictors when considered simultaneously in a multivariate analysis. We controlled for several sociodemographic and clinical variables. Thus, our analysis can be regarded as a conservative test for the prognostic impact of psychosocial variables. Although all of the psychosocial variables showed a significant association with survival in the univariate analysis, HRQOL emerged as the most important one when all of them were entered to compete for incremental value.

Our second main finding revealed that two facets of HRQOL, physical well-being and functional well-being, were predictive of cancer survival. Physical functioning is generally regarded as the HRQOL facet most consistently related to cancer survival [7]. The label of the second HRQOL facet that emerged as important in our study, functional well-being, might generate the interpretation of representing some kind of performance measure. However, an inspection of the items of this subscale reveals that many items are characterized by a very positive,

Table V. Intercorrelations, mean (M), standard deviation (SD) and internal consistency (α) for the subscales of the Functional Assessment of Cancer Therapy-General (FACT-G) (N = 930).

	PWB	SWB	EWB	FWB	RP
PWB	–	0.12	0.52	0.57	0.20
SWB		–	0.20	0.31	0.26
EWB			–	0.54	0.24
FWB				–	0.26
M	19.49	20.90	16.76	16.41	6.54
SD	6.15	4.32	4.90	5.67	1.39
α	0.86	0.58	0.81	0.83	0.76

EWB, emotional well-being; FWB, functional well-being; PWB, physical well-being; RP, relationship with physician; SWB, social/family well-being.

All correlations are significant at $p < 0.001$.

Table VI. Adjusted multivariate Cox proportional hazards model for the Functional Assessment of Therapy-General (FACT-G) subscales (N = 930).

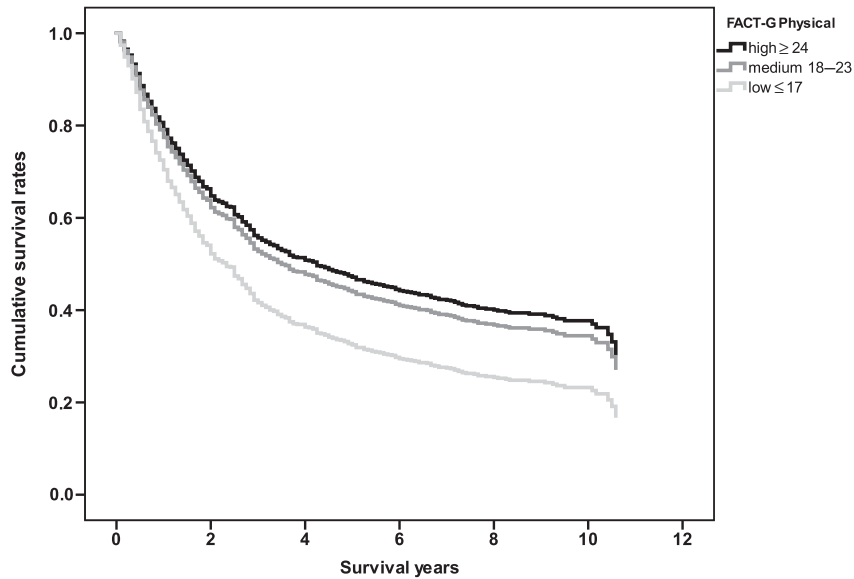
	HR	95% CI	p
PWB	0.971	0.955–0.987	0.001
SWB	0.997	0.977–1.018	0.800
EWB	0.998	0.978–1.018	0.819
FWB	0.980	0.961–0.999	0.037
RP	1.057	0.990–1.128	0.095

EWB, emotional well-being; FWB, functional well-being; PWB, physical well-being; RP, relationship with physician; SWB, social/family well-being.

Adjusted for age, sex, partnership status, educational level, health insurance type, performance status, cancer site, and cancer stage; HRs greater than 1.00 represent an increased risk of death from any cause.

emotional connotation (e.g. work is fulfilling, having accepted illness, enjoying life). Clearly, patients who agree with these items should be more capable and more satisfied with their chores and duties. Besides, this scale seems to tap the construct of positive psychological state. Interestingly, while this positively connotated functional well-being scale was predictive of survival, the emotional well-being scale, which – according to Coyne et al. [21] – can be interpreted as a measure of depression and anxiety, did not predict survival. This is in accordance with the study by Coyne et al. [21] who, in contrast to our work, did not investigate the importance of the remaining FACT-G subscales. Although our full measure of life satisfaction was unrelated to survival in the multivariate analysis, the significant effect of the FACT-G functional well-being scale should encourage researchers to include variables representing positive psychological states in such research.

One relevant challenge to our interpretation of the results is the lack of a symptom measure in our analysis. Many studies showed that apart from global HRQOL or physical functioning, specific symptoms, mainly appetite loss and pain, predict cancer survival [7]. In contrast to the FACT-G, the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30) [22], which is the most widely used instrument for the assessment of HRQOL in cancer, comprises an extensive symptom list. However, the physical well-being subscale of the FACT-G does contain three items pertaining to symptoms (lack of energy, nausea, and pain). Furthermore, one study that applied both the FACT-G as well as the EORTC QLQ-C30 found that the FACT-G functional well-being and physical well-being subscales remained significant predictors of survival despite the inclusion of EORTC QLQ-C30 self-rated symptoms [23]. These results and considerations support the validity of our findings.

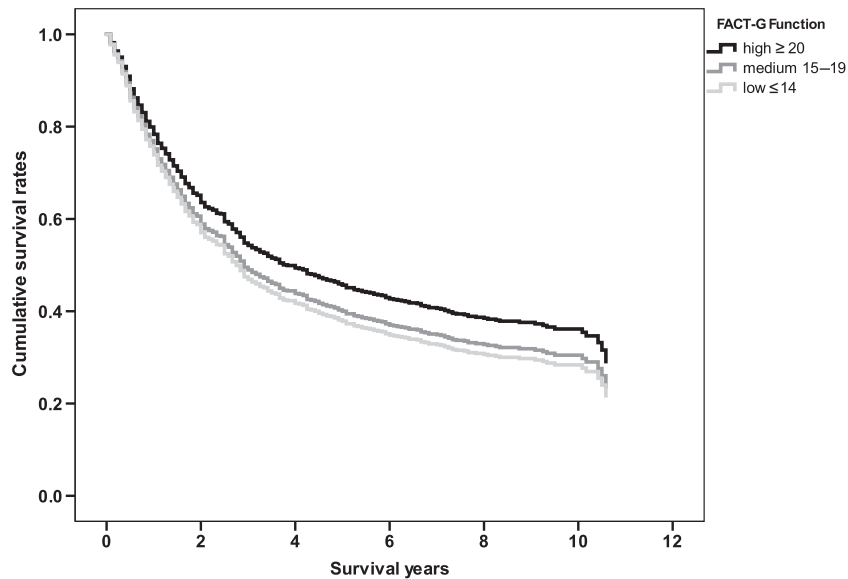


O	N	Number of patients at risk					FACT-G Physical groups	
		202	160	138	92	26	high	≥24
167	299	179	144	126	85	23	medium	18-23
243	319	140	97	86	52	14	low	≤17

Figure 2a. Overall survival rates based on Functional Assessment of Cancer Therapy–General (FACT-G) physical well-being subscale score in three groups of patients, categorized according to tertiles. Survival rates are adjusted for sociodemographic and clinical parameters. N, number of patients; O, number of events (i.e. deaths).

Eventually, our analysis confirmed associations known from previous research [6,7]. With regard to cancer site, the ranking of the five-year survival rates among the cancer types in our study was largely

compatible with the known survival distribution [24,25], although in our study urogenital cancers ranked comparatively low. This should be due to the fact that this category did not exclusively include



O	N	Number of patients at risk					FACT-G Functional groups	
		207	171	150	100	31	high	≥20
162	299	172	134	115	78	20	medium	15-19
203	310	142	96	85	51	12	low	≤14

Figure 2b. Overall survival rates based on Functional Assessment of Cancer Therapy – General (FACT-G) functional well-being subscale score in three groups of patients, categorized according to tertiles. Survival rates are adjusted for sociodemographic and clinical parameters. N, number of patients; O, number of events (i.e. deaths).

patients with prostate cancer, for whom the five-year survival rate is relatively high. Thus, this was a category with comparatively diverse cancers with different survival likelihoods, which is also evident in the large CI for median survival time.

Limitations of our study arise from the significant differences between the study patients and those who declined participation. This bias is mainly due to the case mix of the clinical population treated in the study hospital, which included a high number of patients who received palliative treatment. However, this bias is inevitable once researchers aim to include patients with lower performance status.

To conclude, our results show that among several psychosocial factors health-related quality of life is the most important predictor for long-term survival in cancer patients who are undergoing radiotherapy.

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