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Health utility scores of six common cancers in China measured by SF-6Dv2

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Abstract

Purpose Given the recent update of SF-6Dv2, detailed data on utility scores for cancer patients by cancer type remain scarce in China and other regions, which limits the precision of cost-utility analyses (CUA) in cancer interventions. The aim of the study was to systematically evaluate utility scores of six common cancers in China measured using SF-6Dv2, and identify the potential factors associated with utility scores.

Methods A hospital-based cross-sectional survey was conducted from August 2022 to December 2023. It recruited 896 cancer patients from three tertiary hospitals in China, including 270 with lung cancer, 96 with stomach cancer, 88 with liver cancer, 71 with oesophagus cancer, 142 with colorectum cancer, and 160 with breast cancer. The validated Simplified Chinese version of the SF-6Dv2 was used to calculate utilities based on the Chinese value set, and the utility values were described using the mean and standard deviation (SD). Participants' socio-demographic, behavioral and clinical characteristics were also obtained from the survey. Univariate and multivariate linear regression models were performed to explore the impact of these three categories of characteristics on utility scores derived from SF-6Dv2 for the total cancer patients and each cancer group.

Results The mean utility score was 0.66 (SD = 0.26) for the total cancer sample, 0.66 (SD = 0.25) for lung cancer, 0.75 (SD = 0.23) for stomach cancer, 0.69 (SD = 0.24) for liver cancer, 0.69 (SD = 0.24) for oesophagus cancer, 0.65 (SD = 0.31) for colorectum cancer, and 0.57 (SD = 0.24) for breast cancer. Multivariate linear regression analysis indicated that patients who were older, from larger families, under greater economic pressures, undergoing fewer health examinations, smoking, and in advanced cancer stages had lower utility scores in the total cancer sample ($p<0.05$), with variations observed across different cancer types.

Conclusions This study is one of the first to apply the SF-6Dv2 to a heterogeneous group of cancer patients, providing evidence for conducting CUA with SF-6Dv2 across six common cancers in China. In addition, the study provides a basis for improving interventions for different cancer types.

Keywords Health utility, Cancer, SF-6Dv2, China

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Introduction

Cancer remains a leading cause of death globally [1], with growing concerns over the continuous rise in both incidence and mortality rates [2]. In recent years, the overall incidence rates of cancer in China have continued to rise, underscoring a pressing health challenge [3]. The latest data from the National Cancer Surveillance Sites reveal that new cancer incidences in China have reached 4,064,000 cases, with a crude incidence rate of 293.91 per 100,000 population. Specifically, lung cancer exhibits the highest incidence at 106.06 per 100,000, succeeded by colorectum (51.71 per 100,000), thyroid (46.61 per 100,000), liver (36.77 per 100,000), stomach (35.87 per 100,000), breast (35.72 per 100,000), and oesophagus cancers (22.40 per 100,000) [4]. The administration of this array of malignancies necessitates significant healthcare resources, posing a considerable challenge to China's healthcare system, thereby underscoring the critical importance of efficacious cancer management [5].

Cost-utility analyses (CUAs) serve as pivotal instruments enabling decision-makers to scrutinize the economic implications and therapeutic benefits of oncological interventions [6]. Through the juxtaposition of the financial outlays associated with diverse therapeutic strategies against their health outcomes—predominantly quantified via utility scores for the computation of quality-adjusted life years (QALYs)—CUAs facilitate the discernment of those interventions that yield the most substantial health dividends [7]. In recent years, the EuroQol 5-Dimension (EQ-5D) and the Short Form Six-Dimension (SF-6D) are the two most widely used generic multi-attribute utility instruments (MAUIs) to calculate QALYs [8, 9] and are recommended as the standard measures in the application of health technology assessment across numerous countries [10, 11].

The SF-6D was developed in two versions of SF-6Dv1 [12] and SF-6Dv2 [13] in 2002 and 2020, respectively, both derived from the SF-36 questionnaire. SF-6Dv1 has been extensively applied in cancer patient populations [14–16], valued for its vitality dimension that captures a critical health outcome relevant to these patients, it is not without its criticisms. Scholars have pointed out ambiguities in the physical functioning dimension's severity ordering [17] and an overly positive framing in the vitality dimension compared to others. Additionally, the role dimension exhibits a 'floor' effect due to its limited response range [18, 19], and the standard gamble valuation method, integral to SF-6Dv1, poses cognitive challenges that may skew health state valuations. These identified limitations prompted the development of SF-6Dv2, which aims to address these issues and offer a more nuanced instrument for health outcome assessment [13]. As of the present, value sets for the SF-6Dv2 have been developed and published in Canada [20], Iran [21], Japan [22], Australia [23], the United Kingdom [22], and China [24].

Given the recent update to the SF-6Dv2, there exists a notable scarcity of research employing this instrument within cancer patients in China. To our knowledge, there is currently only one study evaluating its measurement properties in patients with lymphoma cancer in China [25]. The scarcity of research particularly impacts the acquisition of utility scores across a spectrum of cancer types, limiting the potential for integrating SF-6D into widespread CUA and consequently affecting its broader application in health technology assessments and resource allocation strategies.

To improve the precision of CUA in oncology, this study presents the first set of utility scores of SF-6Dv2 for common cancer patients (including those with lung, stomach, liver, esophagus, colorectum, and breast cancer) derived using Chinese utility weights, which is particularly sparse amongst Chinese survivors. Furthermore, this exploration is intended to furnish decision-makers with nuanced insights into shaping these utility scores, thereby facilitating more strategic resource allocation with a heightened focus on factors that substantially affect health utility.

Methods

Study design and patients

Between August 2022 and December 2023, we recruited 896 cancer patients using a consecutive sampling method, from three tertiary hospitals located in Harbin, the capital city of Heilongjiang Province, China. The recruited patients covered six types of cancer: lung, stomach, liver, oesophagus, colorectum, and breast, all of which have a high incidence rate in China [4] (among the top seven cancers by incidence in China, thyroid cancer was not included in this study due to insufficient data availability and a limited investigative focus within our research scope). Inclusion criteria were as follows: (1) a clinical diagnosis of one of the cancer types mentioned above, according to medical records; (2) an expected survival time of more than one year; (3) at least 18 years old; and (4) able to read and communicate in Chinese and complete questionnaires.

In the wards, consenting patients were required to sign an informed consent form, after which trained interviewers conducted face-to-face interviews, recording their responses to the SF-6Dv2 on paper questionnaires. Additionally, the interviewers collected socio-demographic characteristics, including gender, age, residence, marital status, family size (defined as small: 1–3 members, medium: 4–5 members, and large: more than 5 members), education level, employment status, and economic

pressure. Behavioral characteristics, such as health examination status, smoking status, and alcohol consumption status, were also recorded. Furthermore, clinical data, including cancer diagnosis and staging, were extracted from the patients' medical records.

The Ethics Committee of Harbin Medical University (HMUIRB2023005) granted approval for the protocol of this study, which was carried out following the guidelines of the Declaration of Helsinki.

Instruments

The SF-6Dv2 is a revised version of the SF-6Dv1 that is derived from 10 items selected from the SF-36v2 [13]. It has been demonstrated that the SF-6Dv2 can be used as an independent instrument to measure population health utility scores [26].It includes six dimensions—namely, physical functioning, role limitations, social functioning, pain, mental health, and vitality—with each dimension assessed by a single item. Except for the pain dimension, which has 6 levels, the other dimensions employ a 5-level Likert scale, resulting in 18,750 (=5*5*5*6*5*5) different health states [13]. The validated Chinese versions of SF-6Dv2 [27] was used in this study, and the value set for the Chinese SF-6Dv2, developed using the Time Trade-Off method, features utility scores ranging from −0.277 (corresponding to the health state 555655) to 1 (corresponding to the health state 111111) [24].

Statistical methods

Descriptive statistics were employed to analyze the characteristics of patients. Continuous variables (age and utility value) were described by means of mean and standard deviation (SD), while all other variables were categorical and described as frequency and percentage. Additionally, box plots and percentile distribution plots were used to illustrate utility scores and dimension scores of SF-6Dv2.

The mean and SD of SF-6Dv2 utility scores were reported for the total sample and various cancer subgroups, categorized by socio-demographic, behavioral and clinical characteristics. The differences in utility scores among the aforementioned subgroups were assessed using ANOVA or T-tests as appropriate.

A multivariate linear regression model was developed, with all covariates retained in the model regardless of significance, to explore the influence of socio-demographic, behavioral and clinical characteristics on utility scores. Dummy variables were created for multicategory variables, including for missing values. Furthermore, gender was excluded from the models for both the overall cancer sample and the breast cancer subset, due to the gender-specific nature of breast cancer.

Statistical analysis was performed with Statistical Package for Social Sciences version 24.0(SPSS; IBM Corporation, Armonk, NY, USA), Stata version 13, and R version 4.0.5. Differences were considered statistically significant when p-values were less than 0.05.

Results

During the hospital-based survey, a total of 896 cancer patients met the inclusion criteria. However, 46 patients declined to be interviewed, and 23 patients were excluded due to missing key information. Consequently, a total of 827 eligible questionnaires were verified and included in the analysis. These comprised 270 from lung cancer patients, 96 from stomach cancer patients, 88 from liver cancer patients, 71 from esophagus cancer patients, 142 from colorectal cancer patients, and 160 from breast cancer patients.

Participants characteristics

The socio-demographic, behavioral and clinical characteristics of the patients are summarized in Table 1. In the total patient sample, 57.9% were female, largely due to all breast cancer patients being female. The mean age of the patients was over 50 years, with liver cancer patients having the highest mean age at 56.22 (SD = 10.76) years and breast cancer patients the lowest at 51.19 (SD = 9.07) years. Additionally, 83.7% of the patients were married, with breast cancer patients showing the highest marriage rate at 89.4%. The majority of patients were in early stages, with 34.8% at stage I and 32.6% at stage II, notably with colorectum cancer having the highest proportion of stage I at 45.8% and oesophagus cancer the highest rate of stage II at 52.1%.

Utility scores

As shown in Fig. 1, the mean utility score for the total cancer patient sample was 0.66 (SD = 0.26). Among specific cancer types, stomach cancer patients had the highest mean utility score at 0.75 (SD = 0.23), while breast cancer patients had the lowest at 0.57 (SD = 0.24). Patients with lung, liver, esophagus, and colorectum cancers had mean utility scores of 0.66 (SD = 0.25), 0.69 (SD = 0.24), 0.69 (SD = 0.24), and 0.65 (SD = 0.31), respectively, all below the population norm for SF-6Dv2 in China of 0.83 (SD = 0.14) [28].

Distributions of responses to SF-6Dv2 descriptive systems

Responses to the SF-6Dv2 descriptive system from all cancer patients and each specific cancer group are detailed in Fig. 2. We found that problems with physical functioning (67.7 to 89.4%) and vitality (63.5 to 90.6%) and mental health (59.4 to 81.9%) were the top three health problems for patients across most types of cancer. In contrast, pain (49.5 to 80.6%) and social functioning (57.3 to 83.7%) were the least frequently reported

Table 1 Socio-demographic, behavioral and clinical characteristics of the total cancer patients and each cancer group separately

	Total (*N* = 827)	Lung Cancer (*N* = 270)	Stomach Cancer (*N* = 96)	Liver Cancer (*N* = 88)	Oesophagus Cancer (*N* = 71)	Colorectum Cancer (*N* = 142)	Breast Cancer (*N* = 160)
Gender							
Male	348 (42.1%)	135 (50.0%)	53 (55.2%)	48 (54.5%)	35 (49.3%)	77 (54.2%)	
Female	479 (57.9%)	135 (50.0%)	43 (44.8%)	40 (45.5%)	36 (50.7%)	65 (45.8%)	160 (100%)
Age, years[Mean ± SD]	53.66 ± 11.48	53.46 ± 11.57	52.73 ± 13.43	56.22 ± 10.76	53.56 ± 12.81	55.93 ± 11.48	51.19 ± 9.07
Residence							
Urban	453 (54.8%)	135 (50.0%)	46 (47.9%)	43 (48.9%)	42 (59.2%)	94 (66.2%)	93 (58.1%)
Rural	374 (45.2%)	135 (50.0%)	50 (52.1%)	45 (51.1%)	29 (40.8%)	48 (33.8%)	82 (41.9%)
Marital Status							
Unmarried	35 (4.2%)	11 (4.1%)	6 (6.3%)	5 (5.7%)	5 (7.0%)	4 (2.8%)	4 (2.5%)
Married	692 (83.7%)	234 (86.7%)	81 (84.4%)	71 (80.7%)	55 (77.5%)	108 (76.1%)	143 (89.4%)
Other	100 (12.1%)	25 (9.3%)	9 (9.4%)	12 (13.6%)	11 (15.5%)	30 (21.2%)	13 (8.1%)
Family size							
Small family	539 (65.2%)	180 (66.7%)	59 (61.5%)	53 (60.2%)	47 (66.2%)	98 (69.0%)	102 (63.7%)
Medium Family	225 (27.2%)	68 (25.2%)	30 (31.3%)	25 (28.4%)	17 (23.9%)	38 (26.8%)	47 (29.4%)
Large Family	63 (7.6%)	22 (8.2%)	7 (7.3%)	10 (11.4%)	7 (9.9%)	6 (4.2%)	11 (6.9%)
Education level							
Primary education	483 (58.4%)	175 (64.8%)	58 (60.4%)	50 (56.8%)	42 (59.2%)	68 (47.9%)	90 (56.3%)
Secondary education	248 (30.0%)	69 (25.6%)	29 (30.2%)	28 (31.8%)	24 (33.8%)	45 (31.7%)	53 (33.1%)
Higher education	96 (11.6%)	26 (9.6%)	9 (9.4%)	10 (11.4%)	5 (7.0%)	29 (20.4%)	17 (10.6%)
Employment status							
Employed	541 (65.4%)	184 (68.1%)	67 (69.8%)	51 (58.0%)	43 (60.6%)	100 (70.4%)	96 (60.0%)
Repaired	19 7(23.8%)	59 (21.9%)	20 (20.8%)	27 (30.7%)	16 (22.5%)	33 (23.2%)	42 (26.3%)
Unemployed	89 (10.8%)	27 (10.0%)	9 (9.4%)	10 (11.4%)	12 (16.9%)	9 (6.3%)	22 (13.8%)
Economic pressure							
No pressure	120 (14.5%)	27 (10.0%)	22 (22.9%)	13 (14.8%)	16 (22.5%)	31 (21.8%)	11 (6.9%)
Lower pressure	170 (20.6%)	70 (25.9%)	12 (12.5%)	16 (18.2%)	11 (15.5%)	29 (20.4%)	32 (20.0%)
Higher pressure	229 (27.7%)	70 (25.9%)	29 (30.2%)	23 (26.1%)	17 (23.9%)	40 (28.2%)	50 (31.3%)
Huge pressure	308 (37.2%)	103 (38.1%)	33 (34.4%)	36 (40.9%)	27 (38.0%)	42 (29.6%)	67 (41.9%)
Health examinations status							
Regularly	313 (37.8%)	100 (37.0%)	36 (37.5%)	42 (47.7%)	23 (32.4%)	54 (38.0%)	58 (36.3%)
Occasionally	271 (32.8%)	91 (33.7%)	35 (36.5%)	23 (26.1%)	21 (29.6%)	42 (29.6%)	59 (36.9%)
Hardly ever	243 (29.4%)	79 (29.3%)	25 (26.0%)	23 (26.1%)	27 (38.0%)	46 (32.4%)	43 (26.9%)
Smoking status							
No	645 (78.0%)	210 (77.8%)	72 (75.0%)	68 (77.3%)	50 (70.4%)	98 (69.0%)	147 (91.9%)
Yes	182 (22.0%)	60 (22.2%)	24 (25.0%)	20 (22.7%)	21 (29.6%)	44 (31.0%)	13 (8.1%)
Alcohol Consumption status							
No	674 (81.5%)	227 (84.1%)	70 (72.9%)	71 (80.7%)	55 (77.5%)	103 (72.3%)	148 (92.5%)
Yes	153 (18.5%)	43 (15.9%)	26 (27.1%)	17 (19.3%)	16 (22.5%)	39 (27.5%)	12 (7.5%)
Cancer stage							
I	288 (34.8%)	100 (37.0%)	29 (30.2%)	26 (29.5%)	19 (26.8%)	65 (45.8%)	49 (30.6%)
II	270 (32.6%)	89 (33.0%)	28 (29.2%)	29 (33.0%)	37 (52.1%)	22 (15.5%)	65 (40.6%)
III	180 (21.8%)	50 (18.5%)	30 (31.3%)	21 (23.9%)	37 (12.7%)	33 (26.1%)	180 (20.6%)
IV	89 (10.8%)	31 (11.5%)	9 (9.4%)	12 (13.6%)	6 (8.5%)	181 (12.7%)	13 (8.1%)

Family size is defined as small with 1–3 members, medium with 4–5 members, and large with more than 5 members; Primary education is defined as education levels below junior high school, secondary education as high school education, and higher education as college and advanced degrees

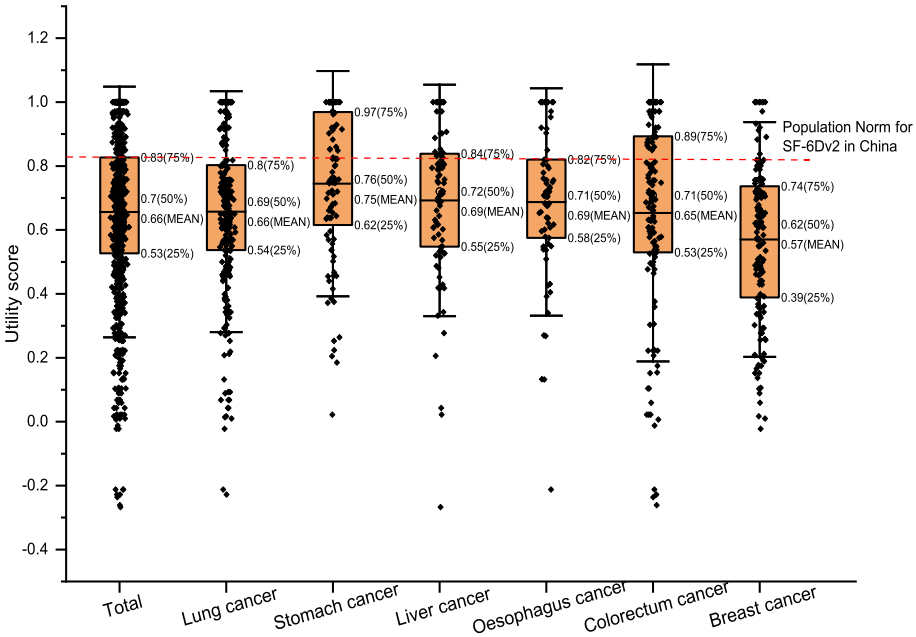

Fig. 1 Utility scores of SF-6Dv2 for the total cancer patients and each cancer group

problems. Among the different types of cancer, breast cancer patients reported the most problems, particularly with vitality (90.6%) and role limitation (90.0%). Stomach cancer patients reported the fewest problems, especially in pain (50%) and social functioning (57.3%).

Mean utility scores by socio-demographic and behavioral characteristic

Mean utility scores for each demographic and behavioral characteristic subgroup for the total cancer patients and each cancer group are shown in Table 2. Univariate analysis in the total cancer patient sample indicated that factors such as gender, age, residence, marital status, family size, education level, economic pressure, frequency of health examinations, smoking, and alcohol consumption significantly affected utility scores, although the results varied across cancer types.

Mean utility scores by cancer stage

Figure 3 shows the mean utility scores for groups defined by cancer stage. For the total sample and each type of cancer patient, the utility scores had a similar downward tendency as the cancer stage advanced, although this trend was not significant in oesophagus and colorectum cancers.

Factors associated with utility scores

Regression of the utility scores on the demographic, behavioral and clinical characteristics was carried out for the total study population and for each specific cancer separately. A summary of these regression results is presented in Table 3. The factors considered explained approximately one-third (Adjusted R^2=0.334) of the variation in utility scores observed across all cancer types. Notably, liver cancer exhibited the highest degree of variation explained (Adjusted R^2=0.482), while breast cancer had the lowest (Adjusted R^2 =0.220).

Among the socio-demographic factors, utility scores significantly decreased with increasing age, especially for patients aged 45–59 years (β= −0.052) and over 60 years (β= −0.108) in the total sample, with significant impacts observed in lung and colorectum cancer patients. Patients from medium-sized (β= −0.049) and large (β= −0.148) families showed significantly lower utility scores than those from small families in the total sample, with significant impacts observed in oesophagus, colorectum and breast cancer patients. In addition, economic pressure also significantly reduced health utility scores, with the most significant decline observed in patients experiencing huge economic pressure(β= −0.333), a trend consistent across all cancer types.

Among the behavioral factors, patients with less frequent health examinations showed significantly lower health utility scores (occasional β= −0.055, hardly ever β= −0.076) compared to those undergoing regular examinations in the total sample, with significant impacts observed in breast cancer patients. Additionally, smoking had a significant negative impact on

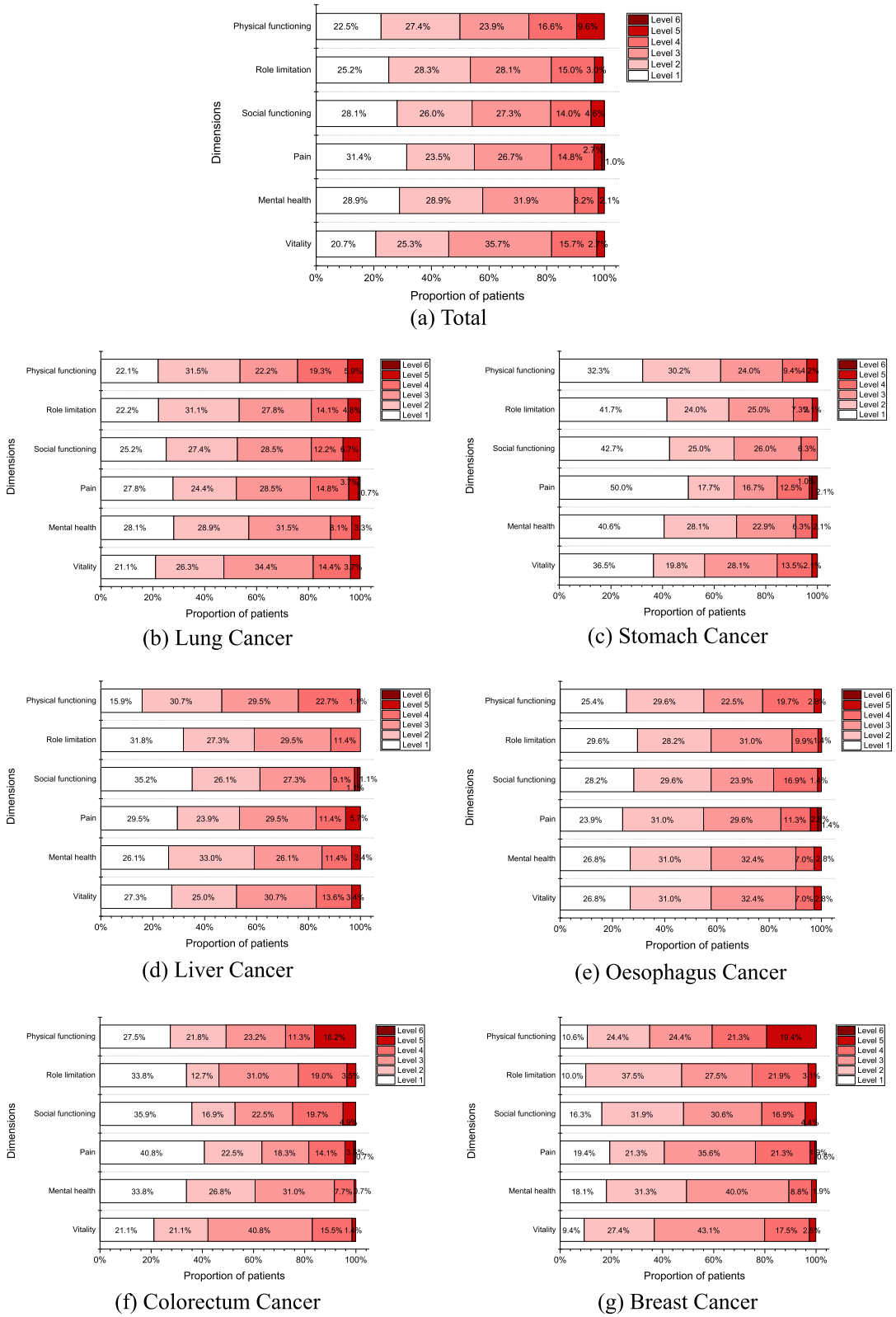

Fig. 2 Responses to the SF-6Dv2 descriptive system from the total cancer patients and each specific cancer group

Table 2 Mean health utility of study participants according to their demographic and behavioral characteristic

	Total		Lung Cancer		Stomach Cancer		Liver Cancer		Oesophagus Cancer		Colorectum Cancer		Breast Cancer	
	Mean (SD)	*p*-value	Mean (SD)	*p*-value	Mean (SD)	*p*-value	Mean (SD)	*p*-value	Mean (SD)	*p*-value	Mean (SD)	*p*-value	Mean (SD)	*p*-value
Gender[a]														
Male	0.65 (0.26)		0.66 (0.26)		0.72 (0.20)		0.68 (0.18)		0.61 (0.25)		0.61 (0.31)		—	
Female	0.70 (0.26)	0.020	0.65 (0.24)	0.890	0.78 (0.27)	0.250	0.71 (0.30)	0.632	0.76 (0.20)	0.005	0.71 (0.30)	0.045	—	—
Age[b]														
18–44	0.74 (0.21)		0.72 (0.20)		0.83 (0.16)		0.75 (0.18)		0.70 (0.22)		0.84 (0.14)		0.66 (0.24)	
45–59	0.65 (0.25)		0.65 (0.25)		0.75 (0.23)		0.69 (0.20)		0.69 (0.19)		0.67 (0.29)		0.56 (0.25)	
> 60	0.61 (0.29)	< 0.001	0.62 (0.27)	0.050	0.67 (0.27)	0.056	0.68 (0.31)	0.692	0.68 (30)	0.943	0.55 (0.35)	0.001	0.50 (0.22)	0.032
Residence[a]														
Urban	0.78 (0.24)		0.68 (0.22)		0.69 (0.23)		0.74 (0.27)		0.70 (0.23)		0.69 (0.26)		0.61 (0.24)	
Rural	0.63 (0.28)	0.020	0.63 (0.28)	0.133	0.80 (0.23)	0.024	0.65 (0.20)	0.093	0.67 (0.26)	0.612	0.58 (0.38)	0.034	0.52 (0.25)	0.031
Marital status[b]														
Unmarried	0.76 (0.19)		0.78 (0.14)		0.81 (0.22)		0.63 (0.12)		0.79 (0.16)		0.87 (0.15)		0.65 (0.18)	
Married	0.65 (0.26)		0.65 (0.26)		0.73 (0.24)		0.71 (0.22)		0.69 (0.25)		0.62 (0.32)		0.57 (0.24)	
Other	0.67 (0.25)	0.037	0.65 (0.18)	0.251	0.86 (0.18)	0.234	0.61 (0.36)	0.388	0.64 (0.22)	0.522	0.74 (0.26)	0.055	0.52 (0.25)	0.590
Family size[b]														
Small family	0.69 (0.24)		0.66 (0.25)		0.79 (0.20)		0.74 (0.21)		0.72 (0.17)		0.72 (0.26)		0.60 (0.23)	
Medium Family	0.62 (0.29)		0.66 (0.22)		0.70 (0.28)		0.64 (0.29)		0.72 (0.29)		0.52 (0.39)		0.54 (0.25)	
Medium Family	0.50 (0.28)	< 0.001	0.58 (0.33)	0.307	0.52 (0.17)	0.007	0.58 (0.21)	0.070	0.41 (0.32)	0.004	0.42 (0.16)	< 0.001	0.37 (0.29)	0.005
Education level[b]														
Primary education	0.64 (0.28)		0.63 (0.27)		0.76 (0.23)		0.68 (0.22)		0.73 (0.24)		0.58 (0.36)		0.54 (0.25)	
Secondary education	0.67 (0.23)		0.70 (0.22)		0.70 (0.25)		0.67 (0.29)		0.67 (0.19)		0.70 (0.23)		0.60 (0.23)	
Higher education	0.71 (0.23)	0.013	0.70 (0.16)	0.109	0.80 (0.20)	0.367	0.82 (0.15)	0.192	0.42 (0.27)	0.019	0.74 (0.24)	0.023	0.66 (0.25)	0.098
Employment status[b]														
Employed	0.66 (0.27)		0.65 (0.27)		0.74 (0.23)		0.67 (0.24)		0.68 (0.26)		0.67 (0.32)		0.58 (0.25)	
Repaired	0.67 (0.23)		0.70 (0.18)		0.72 (0.27)		0.75 (0.66)		0.68 (0.22)		0.67 (0.25)		0.55 (0.23)	
Unemployed	0.62 (0.27)	0.273	0.60 (0.29)	0.244	0.81 (0.17)	0.626	0.66 (0.20)	0.391	0.73 (0.18)	0.784	0.43 (0.36)	0.072	0.55 (0.26)	0.739
Economic pressure[b]														
No pressure	0.91 (0.17)		0.88 (0.19)		0.96 (0.08)		0.97 (0.07)		0.91 (0.22)		0.90 (0.20)		0.86 (0.18)	
Lower pressure	0.75 (0.19)		0.78 (0.18)		0.86 (0.13)		0.79 (0.13)		0.73 (0.21)		0.77 (0.22)		0.62 (0.20)	
Higher pressure	0.61 (0.23)		0.63(0.20)		0.65 (0.24)		0.66 (0.21)		0.56 (0.25)		0.58 (0.29)		0.58 (0.21)	
Huge pressure	0.54 (0.26)	< 0.001	0.53(0.26)	< 0.001	0.64 (0.22)	< 0.001	0.56 (0.24)	< 0.001	0.62 (0.15)	< 0.001	0.47 (0.30)	< 0.001	0.49 (0.26)	< 0.001
Health examinations status[b]														
Regularly	0.73 (0.21)		0.73 (0.17)		0.82 (0.19)		0.74 (0.23)		0.75 (0.17)		0.76 (0.26)		0.66 (0.23)	
Occasionally	0.63 (0.26)		0.62 (0.26)		0.75 (0.24)		0.69 (0.27)		0.58 (0.28)		0.67 (0.27)		0.54 (0.22)	

Table 2 (continued)

	Total		Lung Cancer		Stomach Cancer		Liver Cancer		Oesophagus Cancer		Colorectum Cancer		Breast Cancer	
	Mean (SD)	***p*-value**	**Mean (SD)**	***p*-value**	**Mean (SD)**	***p*-value**	**Mean (SD)**	***p*-value**	**Mean (SD)**	***p*-value**	**Mean (SD)**	***p*-value**	**Mean (SD)**	***p*-value**
Hardly ever	0.58 (0.26)	< 0.001	0.60 (0.30)	0.001	0.64 (0.26)	0.013	0.61 (0.22)	0.123	0.72 (0.24)	0.040	0.51 (0.35)	< 0.001	0.49 (0.27)	0.001
Smoking[a]														
No	0.68 (0.25)		0.54 (0.30)		0.66 (0.25)		0.61 (0.21)		0.55 (0.31)		0.60 (0.31)		0.62 (0.14)	
Yes	0.58 (0.28)	< 0.001	0.69 (0.23)	< 0.001	0.77 (22)	0.043	0.72 (0.25)	0.069	0.75 (0.17)	0.001	0.68 (0.31)	0.157	0.57 (0.25)	0.466
Alcohol Consumption[a]														
No	0.67 (0.25)		0.66 (0.24)		0.79 (0.22)		0.74 (0.20)		0.72 (0.21)		0.69 (0.30)		0.57 (0.25)	
Yes	0.59 (0.29)	< 0.001	0.63 (0.28)	0.453	0.63 (0.25)	0.004	0.49 (0.29)	< 0.001	0.58 (0.31)	0.043	0.57 (0.33)	0.037	0.56 (0.19)	0.895

The analysis of gender differences in the total sample excluded the breast cancer patients

[a] Statistics were estimated by t-test

[b] Statistics were estimated by ANOVA

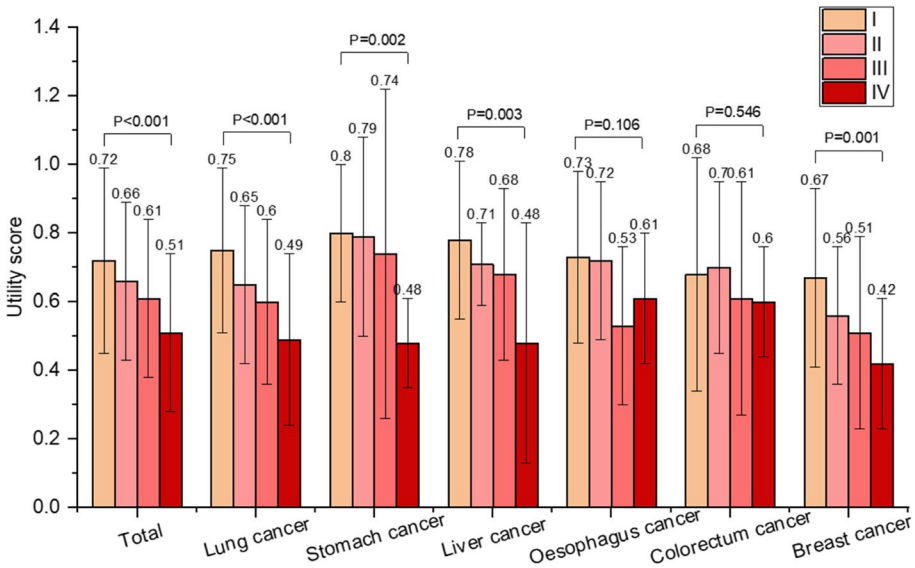

Fig. 3 Mean health utility of study participants according to their cancer stage

utility scores in lung and esophagus cancer patients, while alcohol consumption had a significant negative impact on utility scores in liver cancer patients.

From a clinical perspective, patients with more advanced stages had lower utility scores, especially in stage III ($\beta = -0.060$) and stage IV ($\beta = -0.083$) in the total sample, with a significant impact observed in lung cancer patients.

Discussion

This study is the first to apply the Chinese value set of SF-6Dv2 to such a broad spectrum of cancers, providing utility scores based on varied socio-demographic, behavioral, and clinical characteristics for the most prevalent cancers in China, thus facilitating the application of this instrument in CUA for specific cancer types. Additionally, this study explored in depth the factors influencing health utility in patients with prevalent cancers. These insights are not only valuable to clinicians and policymakers but also provide a robust empirical foundation to guide future medical decisions and health policy initiatives.

The strength of this study is that it provides a unique opportunity to directly compare the health utility scores of various cancer survivors. This study found that the utility scores of patients with each cancer type were below the population norm for SF-6Dv2 in China [28]. Specifically, stomach cancer patients had the highest utility scores, consistent with the results of another study in China that evaluated health utility scores across multiple cancer types (lung, breast, colorectum, oesophagus, liver and stomach cancer) [29]. Conversely, breast cancer patients had the lowest health utility scores, which were lower than the results of a similar study in Iran that also applied the SF-6Dv2 to breast cancer patients [30]. This may be attributed to the gender specificity of this cancer type, consistent with our study's findings and those of other studies that consistently demonstrate poorer health status among women with other cancer types [31–33]. This implies the necessity of incorporating gender-specific considerations into the formulation of treatment and support strategies tailored for breast cancer patients in China, necessitating the development and implementation of culturally sensitive and individually tailored care measures [34, 35].The SF-6Dv2 China value set was used for the first time among a wide range of cancer patients, and thus the lack of evidence on the use of the same instrument to assess health utility scores across multiple cancer types limits the ability to directly compare our findings with other literature. However, the similarities between the utility scores derived from our study and the reliable scores from other instruments published in previous literature [29, 36] highlight the overall representativeness of our estimates.

The problems reported by cancer patients in all dimensions are much more serious than those reported by the general Chinese population [28].The results of this study emphasize the importance of prioritizing physical functioning in cancer care, particularly for liver and breast cancer patients, a priority also highlighted in another study using SF-6Dv2 among Chinese lymphoma patients [25]. Physical functioning is a critical endpoint in clinical trials, plays a pivotal role in assessing treatment efficacy [37, 38], and has proven to be a predictor of survival in

Table 3 Multiple regression of factors influencing SF-6Dv2 utility scores for the total cancer patients and each cancer group

	Total		Lung Cancer		Stomach Cancer		Liver Cancer		Oesophagus Cancer		Colorectum Cancer		Breast Cancer	
	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value
Gender														
Male			Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref		
Female			−0.040	0.135	−0.003	0.937	−0.072	0.148	0.079	0.158	−0.009	0.869		
Age														
18–44	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
45–59	−0.052	0.013	−0.049	0.182	−0.077	0.161	−0.034	0.614	0.026	0.689	−0.033	0.633	−0.040	0.428
>60	−0.108	0.000	−0.091	0.034	−0.100	0.096	−0.096	0.189	0.034	0.655	−0.171	0.033	−0.099	0.148
Residence														
Urban	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Rural	−0.015	0.420	−0.023	0.452	0.007	0.893	−0.075	0.210	−0.056	0.354	−0.051	0.392	−0.013	0.769
Marital status														
Unmarried	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Married	−0.056	0.152	−0.013	0.852	−0.097	0.279	0.026	0.802	−0.100	0.358	−0.066	0.639	−0.047	0.686
Other	−0.034	0.440	0.010	0.900	−0.038	0.723	−0.004	0.976	−0.143	0.246	−0.001	0.994	−0.045	0.730
Family size														
Small family	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Medium Family	−0.049	0.006	0.047	0.129	−0.039	0.417	−0.004	0.936	−0.032	0.618	−0.141	0.018	−0.070	0.093
Medium Family	−0.148	0.000	−0.095	0.055	−0.137	0.089	−0.036	0.637	−0.225	0.015	−0.244	0.026	−0.230	0.003
Education level														
Primary education	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Secondary education	−0.019	0.318	−0.011	0.741	−0.072	0.160	−0.047	0.392	−0.087	0.170	−0.027	0.671	0.014	0.742
Higher education	−0.044	0.102	−0.057	0.259	0.084	0.328	0.033	0.668	−0.288	0.007	−0.037	0.627	−0.067	0.333
Employment status														
Employed	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Repaired	−0.012	0.578	0.002	0.957	0.032	0.551	0.006	0.932	−0.051	0.413	−0.029	0.633	−0.037	0.477
Unemployed	−0.016	0.530	−0.004	0.926	0.086	0.216	−0.052	0.492	−0.010	0.897	0.002	0.982	0.000	1.000
Economic pressure														
No pressure	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Lower pressure	−0.153	0.000	−0.133	0.006	−0.103	0.148	−0.171	0.038	−0.112	0.179	−0.117	0.129	−0.195	0.017
Higher pressure	−0.282	0.000	−0.239	0.000	−0.279	0.000	−0.326	0.000	−0.218	0.004	−0.315	0.000	−0.236	0.003
Huge pressure	−0.333	0.000	−0.335	0.000	−0.268	0.000	−0.374	0.000	−0.200	0.005	−0.422	0.000	−0.291	0.000
Health examinations status														
Regularly	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Occasionally	−0.055	0.003	−0.042	0.210	−0.052	0.277	−0.057	0.292	−0.043	0.511	−0.016	0.784	−0.114	0.012

Table 3 (continued)

	Total		Lung Cancer		Stomach Cancer		Liver Cancer		Oesophagus Cancer		Colorectum Cancer		Breast Cancer	
	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value	β	*p*-value
Hardly ever	−0.076	0.000	−0.055	0.118	−0.069	0.200	−0.019	0.763	0.036	0.536	−0.081	0.245	−0.119	0.024
Smoking														
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	−0.059	0.004	−0.164	0.000	−0.031	0.610	0.028	0.634	−0.130	0.020	−0.029	0.636	0.092	0.181
Alcohol Consumption														
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.011	0.629	0.033	0.386	−0.018	0.761	−0.186	0.006	0.019	0.792	0.047	0.459	−0.030	0.671
Cancer stage														
I	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
II	−0.020	0.271	−0.049	0.121	−0.024	0.638	0.006	0.929	−0.001	0.984	0.063	0.332	−0.082	0.071
III	−0.060	0.004	−0.107	0.004	−0.023	0.644	−0.046	0.486	−0.072	0.384	0.001	0.991	−0.074	0.152
IV	−0.083	0.002	−0.143	0.002	−0.167	0.054	−0.094	0.258	−0.063	0.492	0.127	0.086	−0.125	0.112

Gender was excluded from the models for both the overall cancer sample and the breast cancer subset, due to the gender-specific nature of breast cancer

patients with metastatic cancer [39]. Tailored unsupervised physical activity programs and dietary recommendations are essential for improving physical function in cancer patients [40, 41], particularly those with the aforementioned cancers. Moreover, the results show that vitality is the second most impaired dimension in cancer patients, particularly in those with breast cancer, lung cancer, and colorectum cancer, whose importance has been repeatedly demonstrated in cancer patients [42, 43]. It is even the most impaired dimension in the general Chinese population [28], which may reflect the influence of Chinese physical fitness and cultural perceptions. Research has demonstrated that vitality improvements can be achieved through innovative culinary nutrition interventions [44] and emerging technologies, such as computer-based cognitive bias modification techniques [45], which are necessary to be considered in cancer rehabilitation. Additionally, it is noteworthy that mental health problems are the third most significant problem reported by cancer patients. In clinical settings, mental health often receives less attention during acute treatment periods because it does not directly impair physiological status or daily functioning. However, the literature suggests that neglecting mental health can adversely affect long-term recovery and reintegration, indicating a need for increased focus on this aspect in China [46–48].

The multivariate regression model demonstrated that age, family size, economic pressure, health examination status, smoking and cancer stage significantly influenced utility scores across the total sample, with variations observed among different cancer types. This variability might stem from the enhanced statistical power afforded by the larger sample size. Among socio-demographic characteristics, economic pressure has the greatest impact on the health utility scores of cancer patients, consistent across all types of cancer. This is likely due to limited resources and treatment adherence [49], highlighting the need for increased insurance reimbursement for cancer patients in China [50]. Furthermore, it is essential to develop and implement system-level infrastructure to facilitate financial hardship screening, enhance communication about out-of-pocket costs and employment disruptions, and support financial navigation services for survivors [51].Additionally, in contrast to other well-validated characteristics [52–54], our findings indicate that larger family sizes correlate with lower health utility scores in patients, a phenomenon that, while seemingly counterintuitive, can be elucidated by multiple underlying factors. Firstly, the involvement of family members in treatment decisions, particularly in end-of-life decisions, influences the treatment process [55]. Secondly, larger family sizes may lead to unequal resource distribution, negatively impacting the psychological health and recovery of cancer patients [56]. Additionally, socio-economic factors, including economic and housing stability, significantly affect health outcomes, especially in large families with limited resources [57]. In terms of behavioral characteristics, frequent health examinations significantly enhance health utility scores, especially among breast cancer patients. Regular health examinations facilitate early disease detection, which expands treatment options and improves chances of recovery [53, 54]. They also allow physicians to monitor treatment responses and adjust treatment plans as needed to optimize efficacy and reduce adverse effects. Additionally, this study emphasizes the need for increased focus on lung and esophagus cancer patients who smoke, and liver cancer patients who consume alcohol. Additionally, it is noteworthy that utility scores remain stable in stage I-II patients, but deteriorate sharply in stage III-IV patients, underscoring the importance of early diagnosis and treatment of cancer in maintaining patient health, particularly in lung cancer patients.

This study has several limitations that should be acknowledged. First, the cross-sectional design limits the ability to establish causal relationships or examine temporal trends in health utility scores throughout the cancer treatment process, which is critical for understanding dynamic changes in patient-reported outcomes over time. Second, the study sample was drawn exclusively from three tertiary hospitals in Heilongjiang Province, potentially restricting the generalizability of the findings. Regional variations in lifestyle, socioeconomic status, and access to healthcare resources may lead to differences in health utility scores, which were not captured in this study. Third, the analysis did not incorporate all potential determinants of health utility, such as family dynamics, psychological well-being, and other social factors that are crucial for a more comprehensive understanding of patient outcomes. Addressing these limitations in future research, such as by using longitudinal designs, diversifying sampling regions, and integrating broader psychosocial and demographic variables, could enhance the applicability and impact of the findings for clinical and policy decision-making.

Conclusion

This study provides the first set of SF-6Dv2 utility scores for common cancer sites derived using Chinese utility weights, offering a foundational reference for conducting CUA across different cancer types in China. These results can serve as a valuable resource for economic modelers, researchers, and clinicians. However, the findings should be interpreted with caution, as the cross-sectional nature of the study and potential unmeasured confounding factors may limit the generalizability of the

results. Additionally, the study underscores the need for targeted support strategies and precision cancer care tailored to vulnerable populations, such as older patients, those from larger families, individuals facing economic pressures, smokers, and patients at more advanced cancer stages. Future research is warranted to explore longitudinal changes in utility scores and to assess the impact of specific interventions aimed at improving health outcomes and quality of life in these populations.

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Authors' contributions
All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by LX,JS and LL. The first draft of the manuscript was written by YT, YC and WH, and all authors commented on previous versions of the manuscript. Supervision and validation were provided by HY and TZ. Funding acquisition was managed by WH. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The protocol of this study received approval from the Ethics Committee of Harbin Medical University (HMUIRB2023005).
Informed consent was obtained from all individual participants included in the study.

Competing interests
The authors declare no competing interests.

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