RESEARCH ARTICLE

Editorial Process: Submission:10/23/2022 Acceptance:04/06/2023

Health-Related Quality of Life (HRQoL) Using EQ-5D-5L: Value Set Derived for Indian Breast Cancer Cohort

Tabassum Wadasadawala[1]*, Sanjay K Mohanty[2], Soumendu Sen[2], Pijush Kanti Khan[3], Sharmila Pimple[4], Jaykumar V Mane[4], Rajiv Sarin[4], Sudeep Gupta[4], Vani Parmar[4]

Abstract

Objective: The purpose of this study was to report quality of life of newly diagnosed breast cancer patients from India in a large cohort using the EQ-5D-5L instrument. **Methods:** The study used longitudinal data of 500 breast cancer and 200 non-cancer subjects registered at our centre, during June 2019 and March 2022. The EQ-5D-5L and EQ-VAS instruments were used to measure and compare utility scores among cancer and non-cancer subjects. Descriptive statistics were analyzed and Tobit regression model were used to confirm the predictors of the utility score. **Results:** The cancer subjects had a mean EQ-ED-5L utility score of 0.8703 (SD=0.121), 0.8745 (SD=0.094) and 0.8902 (SD=0.107) at the time of baseline, completion and follow up surveys respectively. EQ-5D-5L values had significantly worsened after diagnosis of cancer as compared to the non-cancer cohort (0.87 vs. 0.93, p value 0.000). EQ-5D-5L utility scores as per stage for the cancer cohort were 0.88, 0.86 and 0.83 respectively for stage I-II, III and IV. Similarly, the EQ-VAS scores for stage I-II, III and IV were 74.9, 72.6 and 73.2 respectively. Multivariate analysis confirmed strong association of age, religion and income with the utility-values. **Conclusion:** This is the first longitudinal study reporting the utility scores derived from a large cohort of breast cancer patients demonstrating lower utility scores compared to non-cancer cohort. The utility scores also improve post treatment completion for cancer patients and decrease with higher stage at diagnosis. This information will be useful for future health economic research in India pertaining to breast cancer.

Keywords: EQ-5D-5L- quality of life- health state utility- breast cancer- India

Asian Pac J Cancer Prev, **24 (4)**, 1199-1207

Introduction

Breast cancer incidence in India is rising at an alarming rate. The age-standardised incidence rate of breast cancer has increased from 0.5 million to 1 million over the past two and half decades and thereby making breast cancer the most common female malignancy both in urban as well as rural India (Dhillon et al., 2018). Breast cancer is not only the commonest cause of cancer death in women but also most common contributor to disability-adjusted life years (DALYs) as per the 2016 Lancet report (Dhillon et al., 2018). Late diagnosis and morbidity from cancer treatment affect the length and quality of life of cancer survivors. Though stage by stage cancer survival is increasing with the improvement in cancer care, the adverse impact of cancer and its treatment cannot be estimated without patient-reported outcomes (PRO) and health-related quality of life (HRQoL) data.

The inequitable access to cancer care has promoted comparative economic evaluations of health interventions that aid the government in decision-making for the inclusion of various cost-effective interventions in the public health insurance schemes. Moreover, health economic research has also gained popularity in any interventional clinical trials as it allows investigators to evaluate the direct cost-effectiveness of different treatment modalities. Among different methods of economic evaluation, cost-utility analysis is preferred for comparative analysis. In this analysis, outcome is measured in the form of quality-adjusted life years (QALY) which is a utility-based index. QALY has two essential components, viz, longevity or life span and utility scores for the health condition under consideration. QALY is the preferred measure for economic evaluation and the EQ-5D-5L is the most recommended instrument to derive utility scores (Huang et al., 2018; Jyani et al., 2020b).

The EQ-5D was developed by the EuroQol Group in the 1980s to provide a concise, generic instrument that could be used to measure, compare and value health status across disease areas (EuroQol, 2022). However,

*[1]Advanced Center for Treatment Research and Education in Cancer, Tata Memorial Center, Mumbai, Homi Bhabha National Institute, India. [2]International Institute for Population Sciences, Mumbai, India. [3]International Institute of Health Management Research, New Delhi, India. [4]Tata Memorial Center, Homi Bhabha National Institute, Mumbai, India. *For Correspondence: twadasadawala@actrec.gov.in*

disease-specific utility scores are more valued over the generic value set (derived from general population) as these are based on the target population (in this case breast cancer patients). Hence it is advisable to obtain utility-based value set from the target population in order to calculate QALYs. Though utility value sets for breast cancer have been published earlier from other countries, it is unlikely that these values will be useful for Indian patients because of the differences in the sociodemographic profile, per capita income, insurance coverage and country requirements (Cheung et al., 2014; Yousefi, 2016).

The aim of this study was to report Health State Utility (HSU) in a large cohort of newly diagnosed breast cancer patients from India using the EQ-5D-5L. Previous studies report QoL of Indian women with breast cancer using FACT B instrument as well as of cancer caregivers using Caregiver Quality of Life Cancer (CQoLC) index (Amarsheda & Bhise 2021, Vashistha et al., 2019). Recently, the Indian value sets of EQ-5D-5L instrument for the general population have been published and made available in the public domain (Jyani et al., 2020a). However, the use of EQ-5D-5L instrument has been reported in very few oncological studies from India (Jyani et al., 2020b). The current study reports the EQ-5D-5L data collected for newly diagnosed breast cancer women who were registered at Tata Memorial Center (TMC) and seeking cancer directed treatment.

Materials and Methods

Study design and accrual

This study was carried out as a collaborative research project by Tata Memorial Center (TMC) and International Institute for Population Sciences (IIPS), Mumbai. The project was approved by the institutional ethics committee at TMC as well as the Academic Research Council at IIPS. The study was also registered on the Clinical Trial Registry of India (CTRI/2019/07/020142). This study is a comprehensive study evaluating the health expenditure on breast cancer treatment as well as estimating the HSU values in a large prospective cohort of breast cancer patients evaluated at TMC and seeking cancer directed treatment. The project accrued study subjects from two different cohorts: cancer cohort and non-cancer cohort. The target accrual of 500 breast cancer patients based on convenient sampling was completed over a period from September 2019 to December 2021. Similarly, target accrual of 200 non-cancer subjects from the individuals visiting the prevention oncology department at TMC was also accomplished during the same period.

All adult histologically confirmed breast cancer patients of stage I to IV who were willing to share relevant socio-demographic information, details of expenditure on cancer treatment and were able to fill or respond to the quality of life (QOL) instruments were screened for the study. Written informed consent was obtained from all the study participants. The data collection was locked on 31st March 2022. At the time of start of the project, the Indian value set for the general population was not available. Hence, cohort of non-cancer subjects was also enrolled in order to get comparative estimates of health status of cancer vs. non-cancer female adult in India.

Measures

The EQ-5D-5L instrument: Aiming at valuing health states gave the potential for the instrument to estimate quality-adjusted life-years (QALYs) for use in cost effectiveness analysis. With the adoption of health technology assessment (HTA) by various countries for decision making on health interventions, QALY has been increasingly used as an important tool in the health economic evaluations both for generating large-scale data covering the entire population as well as in clinical trials.

The EQ-5D-5L first part consists of five descriptors related to mobility, self-care, usual activities, pain/discomfort, and anxiety/ depression. Patients are asked to rate the ability to perform the function from one of the five-responses: no problems, slight problems, moderate problems, severe problems, and extreme problems. The responses are taken in Likert scale, such as, 1 for no problem to 5 for extreme problem. This gives 1-digit number for each of the five dimensions and the combined 5-digit number describes the current health status of the respondent. For instance, if a respondent provides no problem for each of the five dimensions, the health state will be recorded as 11,111 and if respondent has extreme problem in all five dimensions, the health state would be 55,555. A total of 3,125 health states can be derived by the potential combinations of responses. Each of these combinations has a unique utility score value that is already validated and published for India (Jyani et al., 2020). For the Indian value set, health state 11,111 gets utility score value of 1 whereas for 55,555 it is -0.923.

The second part of the EQ-5D-5L comprises of an EQ Visual Analogue scale (EQ VAS) on a 20-cm vertical scale with endpoints labelled ‘the best health you can imagine’ and ‘the worst health you can imagine’ at the two ends of the scale.

For this study, already available validated instruments of EQ-5D-5L in English, Hindi and Marathi languages were used. The QOL instrument was served to cancer patients at three time points: baseline within 4 weeks of cancer diagnosis, within 4 weeks from treatment completion) and during the controlled state i.e during the first follow up visit (6 months from treatment completion). QOL data from the non-cancer cohort was collected only once at the time of registration. This paper describes the baseline utility values for the cancer cohort, impact of transition from one state to another on utility values and compares with the non-cancer cohort using the Indian general utility value set. In our future work, disease specific quality of life assessed using EORTC-QLQ-C30 and BR 23 and its mapping with the EQ-5D-5L will be reported.

Statistical analysis

The EQ-5D-5L utility values depending upon the rating of the five health dimensions done by the patients were derived from the recently published Indian value set (Jyani et al., 2020a). The EQ-VAS scores were analysed directly from the scale served to the patients. We assess

the correlation of EQ-5D-5L and EQ-VAS scores using Pearson's correlation coefficient. We used bivariate analyses and Tobit regression model to understand the predictors of quality of life. Two-sided p-values were used and value of < 0.05 was considered statistically significant. STATA version 17 was used for statistical analysis.

Results

Demographic characteristics of the study sample

In the current paper, 500 cancer patients were compared with the non-cancer cohort of 200 subjects. The non-cancer females who visited the preventive oncology department for their preventive health check-up formed the non-cancer cohort. The baseline demographic details were recorded at the time of accrual for both the cancer and heathy (non-cancer) cohort. The comparison of the two cohorts implies that the non-cancer cohort and the cancer cohort are naturally expected to have different epidemiological and socio-economic background. The non-cancer cohort predominantly belonged to the Mumbai and sub-urban region thereby resulting in the difference between the demographic variables as shown in Table 1. The median time of treatment completion of the cancer cohort was 9 months.

Comparison of EQ-5D-5L between cancer and non-cancer cohort

In the analysis of EQ-5D-5L data, the five domains mobility, self-care, usual activity, pain/discomfort and anxiety/depression were studied. Proportion of subjects in the two groups having problems on a 5-point scale (no, slight, moderate, severe, extreme) were considered. This is shown in Table 2 below. All the three positive health states (mobility, self-care and usual activity) were reported to a higher extent in the non-cancer cohort while the negative health states (pain/discomfort and anxiety/depression) were more frequent in the cancer cohort. Figure 1 shows the comparative data between the two cohorts. Figure 2 shows the distribution of the baseline EQ-5D-5L and EQ-VAS scores for cancer cohort and non-cancer cohort respectively.

EQ-5D-5L utility scores as per stage for the cancer cohort were 0.88, 0.86 and 0.83 respectively for stage I-II, III and IV. Similarly, the EQ-VAS scores for stage I-II, III and IV were 74.9, 72.6 and 73.2 respectively. While the quality of life improves for stage I-II and III, it reduces for stage IV cancer. compared to post treatment assessment. The stage IV cohort primarily comprised of patients who had limited (oligo) metastatic disease and were treated with curative intent.

The mean utility value for the baseline, completion and follow up states of cancer cohort and non-cancer cohort have been reported in Table 3. Thus, the difference in the two cohorts was statistically significant by both the methods of assessment of utility scores. The utility values showed a significant positive trend in the controlled state compared to baseline while the completion values were not statistically significant from baseline as measured by EQ-5D-5L but significantly worse as assessed by VAS. However, there was positive correlations between mean utility score and VAS for each of the time period (for baseline it was 0.5, conclusion it was 0.4 and for follow up it was 0.6).

In order to study the effect of various socio-economic

Table 1. Demographic Profile of the Cancer and Non-Cancer Cohort

Socio-demographic characteristics	Cancer (in %)	Non-cancer (in %)	p-value
Age (in years)			
Mean age in years	46.9	41.5	0.000
Below 40	30.4	46.8	0.000
41 to 59	57.4	46.8	
60+	12.2	6.5	
Education			
Mean years of schooling	7	10	0.000
Illiterate	26.6	13.9	0.000
Primary	21.2	13.9	
Secondary	25.4	24.4	
Higher secondary and above	26.8	47.8	
Religion			
Hindu	78.8	89.6	0.001
Others	21.2	10.5	
Social group			
Unreserved	51.8	59.2	0.114
Scheduled Caste/Scheduled Tribe	33.8	25.9	
Other Backward Class	14.4	14.9	
Wealth quintile			
Poorest	20	20.4	1.000
Poorer	20	19.9	
Middle	20	19.9	
Richer	20	20.4	
Richest	20	19.4	
Household size			
1 to 4	49.6	63.7	0.002
5 to 6	35.8	28.4	
7 and more	14.6	8	
Health insurance			
Yes	9	28.9	0.000
No	91	71.1	
Place of residence			
Urban	46.4	76.6	0.000
Rural	53.6	23.4	
Annual household income			
Less than 50,000	22.4	8	0.000
50,000- 1lac	23.4	16.1	
1 lac- 2 lac	22.2	25.6	
More than 2 lacs	32	50.3	
Clinical stages			
I & II	33.6	NA	NA
III	60.8	NA	
IV	5.6	NA	

Note: Chi-square test for categorical variables and t-test for continuous variables were performed.

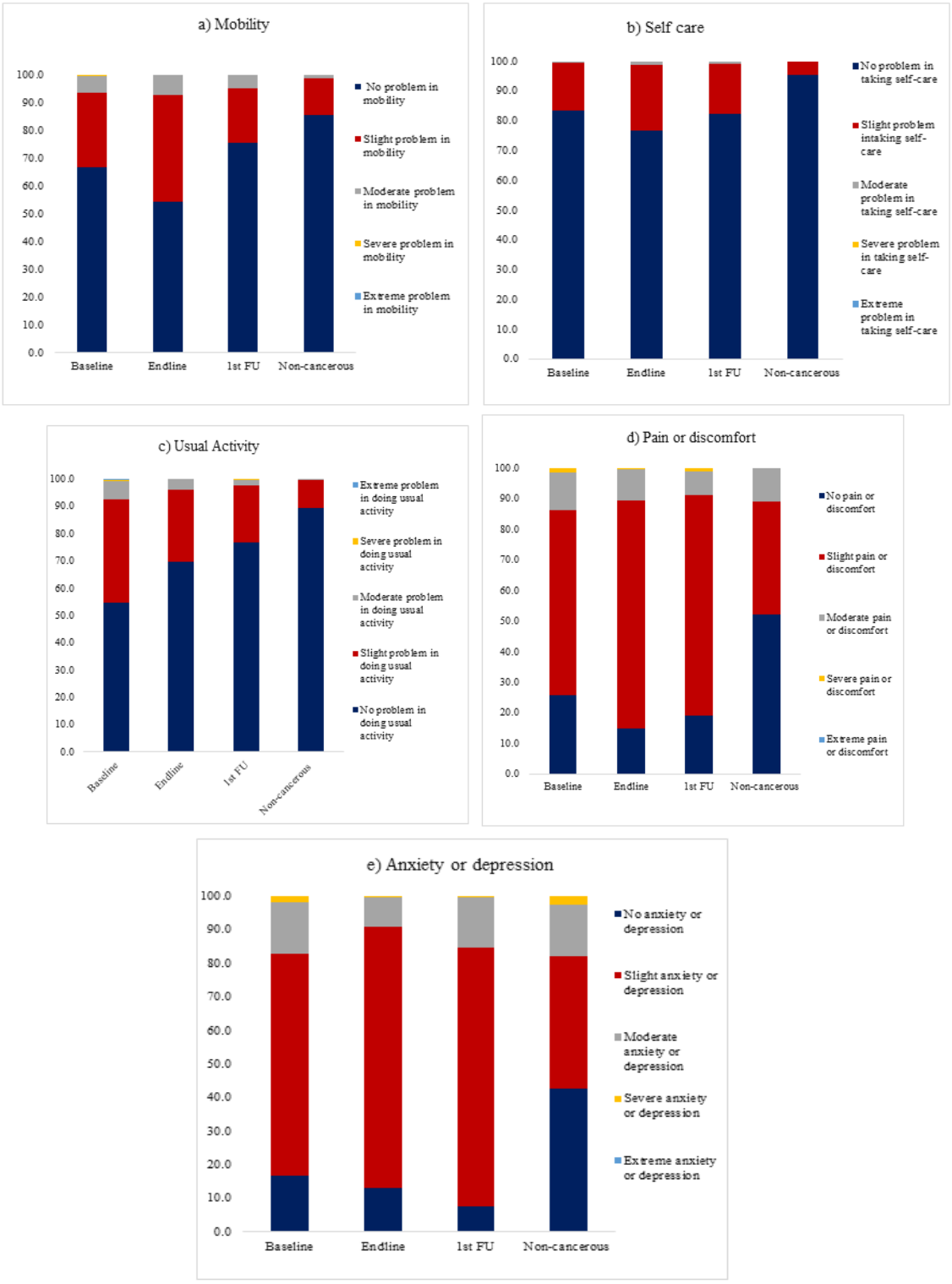

Figure 1. Comparative EQ-5D-5L Data from Cancer and Non-Cancer Cohort on a) mobility b) self-care c) usual activity d) pain or discomfort e) anxiety or depression at different treatment stages.

Table 2. Comparative EQ-5D-5L Data from Cancer and Non-Cancer Cohort

	Mobility (%)		Self - Care (%)		Usual Activity (%)		Pain/Discomfort (%)		Anxiety/Depression (%)	
Problems	Cancer	Non-Cancer	Cancer	Non-Cancer	Cancer	Non-Cancer	Cancer	Non-Cancer	Cancer	Non-Cancer
No	66.8	85.6	83.4	95.5	54.8	89.6	25.6	52.2	16.6	42.8
Slight	27.0	13.4	16.2	4.5	37.8	10.0	60.6	36.8	66.2	39.3
Moderate	6.0	1.0	0.4	0.0	6.6	0.5	12.4	11.0	15.2	15.4
Severe	0.2	0.0	0.0	0.0	0.4	0.0	1.4	0.0	2.0	2.5
Extreme	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0

Table 3. Comparative EQ-5D-5L and VAS Scores from Non-Cancer and Cancer Cohort at Different Time Points

	Mean utility score		VAS score	
Cancer	Mean± SD	p-value*	Mean ±SD	p-value*
Baseline	0.8703±0.121	NA	73.43 ± 12.66	NA
Completion	0.8745 ± 0.094	0.557	69.81 ± 10.14	0.000
Follow up	0.8902 ± 0.107	0.043	71.56 ± 10.50	0.063
Non-cancer	0.9323 ± 0.082	0.000	78.88 ± 13.65	0.000

*t-test was done using baseline value; NA, Not applicable

variables, we carried out bivariate analysis independently for both the cohorts (baseline data was used in the cancer cohort). Age, religion, social group, educational and marital status, wealth quintile, family type, household size, health insurance, place of residence, annual income and cancer stage were considered for the analyse. The results are shown in Table 4 below. It was observed that younger age, Hindu religion and higher income had

Table 4. Socio-Economic Differential of Mean EQ-5D-5L Score among Baseline Cancer Patients and Non-Cancer Cohort (bivariate analysis)

Socio-economic characteristics	Cancer		Non-cancer	
	Mean EQ-5D-5L score	p-value	Mean EQ-5D-5L score	p-value
Age (in years)				
Below 40	0.882±0.117	0.0642	0.947±0.071	0.0722
41 to 59	0.870±0.121		0.920±0.090	
60+	0.839±0.127		0.918±0.094	
Education				
Illiterate	0.857±0.122	0.3512	0.908±0.103	0.1875
Primary	0.870±0.120		0.922±0.091	
Secondary	0.872±0.113		0.929±0.076	
Higher secondary and above	0.883±0.129		0.944±0.075	
Marital status				
Currently married	0.871±0.123	0.6781	NA	NA
Others	0.865±0.108		NA	
Religion				
Hindu	0.877±0.117	0.0148	0.937±0.083	0.0288
Others	0.845±0.132		0.895±0.072	
Household size				
1 to 4	0.878±0.111	0.3995	0.935±0.080	0.803
5 to 6	0.862±0.133		0.928±0.090	
7 and more	0.866±0.125		0.925±0.077	
Health insurance				
Yes	0.892±0.130	0.2065	0.942±0.076	0.2982
No	0.868±0.120		0.928±0.085	
Place of residence				
Urban	0.872±0.126	0.7276	0.939±0.078	0.0406
Rural	0.869±0.117		0.911±0.093	
Annual household income				
Less than 50,000	0.843±0.138	0.0364	0.881±0.091	0.0242
50,000- 1lac	0.869±0.101		0.923±0.082	
1 lac- 2 lac	0.877±0.124		0.927±0.090	
More than 2lac	0.886±0.117		0.945±0.075	
Cancer stage				
I & II	0.884±0.093	0.0894	NA	NA
III	0.866±0.126		NA	
IV	0.836±0.187		NA	

p-value: *<0.1, ** <0.05, *** <0.01; NA, Not applicable

Table 5. Socio-Economic Determinants of EQ-5D-5L Score among Baseline Cancerous and Non-Cancerous Group (multivariate analysis)

	Cancer		Non-cancer	
	Co-efficient	Confidence interval (CI)	Co-efficient	Confidence interval (CI)
Age (in years)				
Below 40®				
41 to 59	-0.018	[-0.045, 0.008]	-0.049***	[-0.082, -0.015]
60+	-0.053**	[-0.094, -0.013]	-0.032	[-0.1, 0.035]
Education				
Illiterate®				
Primary	0.007	[-0.027, 0.04]	0.011	[-0.049, 0.071]
Secondary	0.005	[-0.028, 0.038]	0.019	[-0.037, 0.075]
HS and above	0.002	[-0.033, 0.037]	0.023	[-0.032, 0.077]
Religion				
Hindu®				
Others	-0.033**	[-0.061, -0.005]	-0.059**	[-0.11, -0.008]
Household size				
1 to 4®				
5 to 6	-0.013	[-0.038, 0.013]	0.011	[-0.025, 0.048]
7 and more	-0.01	[-0.045, 0.026]	-0.001	[-0.065, 0.063]
Health insurance				
Yes®				
No	0.009	[-0.034, 0.052]	-0.005	[-0.045, 0.034]
Place of residence				
Urban®				
Rural	0.001	[-0.023, 0.024]	-0.03	[-0.07, 0.01]
Annual household income				
Less than 50000®				
50000- 1lac	0.022	[-0.011, 0.055]	0.046	[-0.021, 0.113]
1 lac- 2 lac	0.038**	[0.004, 0.073]	0.049	[-0.017, 0.116]
More than 2lac	0.045**	[0.011, 0.079]	0.07**	[0.006, 0.135]
Cancer stage				
I & II®				
III	-0.017	[-0.042, 0.008]	N.A.	
IV	-0.048*	[-0.1, 0.004]	N.A.	
Constant	0.885***	[0.835, 0.934]	0.926***	[0.856, 0.995]

p-value: *<0.1, ** <0.05, *** <0.01; NA, Not applicable

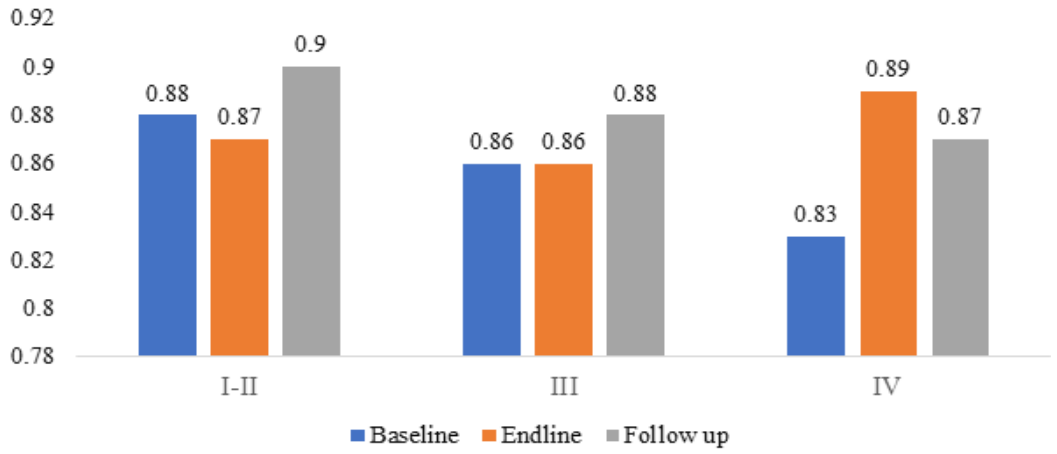

Figure 2. Temporal Trend of Mean Utility Score by Stage of Cancer Diagnosis

Table 6. Review of Literature of Available Health State Utility Studies for Breast Cancer

Author	Country (N)	Mean Utility value	Median Utility value	SD of utility value	Setting	Instrument
Eun-ju Kim et al. (2012)	Korea (509)	0.82	-	0.16	Metastatic	EQ-5D-5L-3L and EORTC C-30 and BR23
Mahmood Yousef et al. (2016)	Iran (163)	0.685	0.761	0.216	Primary, recurrent, stable and metastatic states	EQ-5D-3L and SF-6D
Cheung et al (2014)	China (238)	0.777 (Japan) 0.785 (UK)	0.740 (Japan) 0.777 (UK)	0.163 (Japan) 0.200 (UK)	Curative. Palliative, follow up	EQ-5D-5L and FACT-B
Takeru Shiroiwa et al (2011)	Japan (300)	0.720 to 0.843 in different types of chemo#	-	-	Curative on chemotherapy and follow up	EQ-5D-3L and FACT-B
Seon-Ha Kim et al (2017)	Korea (199)	0.352 to 0.804 in different states	0.300 to 0.900	0.255 to 0.275	8 hypothetical states, metastatic and non-metastatic	VAS and SG
Tzu-Chun Chou et al (2020)	Taiwan, (104)	0.04 to 0.62 in different states of MBC*	-0.02 to 0.68	0.33 to 0.47	Metastatic breast cancer	VAS and TTO method
Current study	India (500)	0.87	0.88	0.121	Stage I to IV breast cancer, , measured at baseline, endline and follow up	EQ-5D-5L and VAS

*Progression-free 0.43, responding 0.62, progressing 0.22 and palliative 0.04; #ACP 0.764, ACD 0.843, PTX 0.742 and DTX 0.720; UVAS i = (Raw score of health state i - Raw score of dead)/ Raw score of perfect health - Raw score of dead)

positive impact on the utility values in both the cohorts but the difference was statistically significant only for the religion and income while the association with age showed a decreasing trend for statistical significance in both the cohorts. In addition, cancer stage also impacted utility scores showing a trend towards statistical significance. Multivariate analysis also confirmed the strong association of age, religion and income with the utility values (Table 5).

Discussion

Public health systems of developing countries like India have to tackle infectious diseases as well as non-communicable diseases (NCD) which are increasing at an exponential rate. The factors contributing to the increased prevalence of NCD include early age at diagnosis, lack of health awareness resulting in late diagnosis and lack of access to health care facilities. These issues are particularly more relevant in oncology as cancer treatment which involves multidisciplinary care is available mainly in the urban areas. The increased vulnerability of the rural population is the direct manifestation of poor access and low insurance coverage.

Under such circumstances, India has launched the ambitious public health insurance scheme to bridge the gap between access to care and financial risk. However, it is important to link health packages with clinically approved treatment guidelines to deliver optimal cancer care. This requires sound scientific knowledge about the clinical benefit of various health interventions and their impact on patient reported outcomes (PRO). Though data is available from the clinical trials, very often the instruments used are not directly useful in calculation of utility of various health states. They require mapping to the commonly recommended tools like the EQ-5D-5L. Moreover, the clinical trial data may not be fully representative of the real-world population based on the eligibility criteria employed in various trials. Hence, the current study for estimating utilities from real-world population was undertaken using previously validated and recommended tools.

The EQ-5D-5L instrument has been applied in a variety of health sector settings like population health studies and health technology assessments wherein it captures the patient-reported outcome from patients suffering from varied clinical conditions. In 2009, NHS England introduced its Patient Reported Outcome Measures (PROMs) programme which comprised of the EQ-5D alongside condition-specific PROs for a variety of medical conditions (NIHCR, 2022). These data are used to monitor the performance of healthcare providers, incentivize quality by linking reimbursement to performance, and inform patients in making appropriate choice of the service provider. Similar uses of EQ-5D are underway, or planned, in the healthcare system like the private insurance companies in Sweden, Canada, Australia and New Zealand.

In this article we report the HSU derived from a large cohort of breast cancer women taking treatment at TMC. To the best of our knowledge, such a report of utility value sets from India for breast cancer has not been published earlier. It was observed that the EQ-5D-5L values had numerically worsened after diagnosis of cancer as compared to the non-cancer cohort. However, the difference was not significant for EQ-5D-5L scores. A discrepancy was noted in the values derived by the two methods i.e. EQ-5D-5L and EQ-VAS. This observation was noted for both cancer as well as non-cancer cohort. The mean difference in percentage distribution of the 5 dimensions in moderate-extreme problem category between the cancer and non-cancer cohort was 5.2% (19), 0.4% (12), 6.9% (35), 2.8% (27) and -0.7% (26) for mobility, self-care, usual activity, pain/discomfort and anxiety/depression respectively. Similarly, cancer affected all domains of the EQ-5D-5L as observed

from the lower percentage of cancer patients in the "no problem" category and the difference between cancer and non-cancer ranged from 12 to 35% for this category. A similar trend was also noted for the VAS-derived values. The utility values among cancer patients improved over 6 months which was significant compared to the baseline estimate. It however did not reach the values comparable to the non-cancer cohort. The recently published Indian value set also reported a mean value of 0.84 (SD 0.209) for the overall female participants (Jyani et al., 2022). Though utility values for other demographic variables have been reported, no separate gender-wise data is available. The socio-economic determinants of the EQ-5D-5L scores found in this study corroborate with the results from the DIVINE study published recently by Jyani et al., (2020).

We found statistically significant association of utility scores with age, religion, marital status, annual income and cancer stage but not for educational status and place of residence as reported in the DEVINE study.

The health state utility data sets on breast cancer have been reported from several countries but there is heterogeneity in the methods of deriving the utility scores as well as in the population studied. The available literature has been tabulated below (Table 6). It can be noted that EQ-5D-5L is the most commonly used tool, but the earlier studies have used the EQ-5D-3L in which only 243 health states can be analysed as against the EQ-5D-5L in which 3125 health states can be studied. The only study comparable to the current study is the Chinese study that evaluated breast cancer patients in combined curative treatment, palliative treatment and follow up phases (Cheung et al., 2014). The Indian value seen in this study is higher (0.87) compared to the Chinese (0.777 or 0.785) value and could be related to the limited proportion of stage IV patients in our study (6% vs 33%).

To assess whether the non-cancer cohort was representative of general population, we compared the key socio-demographic determinants like age, education, marital status, social group and religion with the 2011 census report of the country. Similarly, we compared the cancer cohort with the breast cancer 2020 report published by the National Cancer Registry Program (NCDIR) and the large breast cancer multi-institutional cohort study of non-metastatic breast cancer (NCRP, 2020). While health economic evaluations require generic measures like EQ-5D-5L, SF-6, HUI etc. for broader generalizability across different health conditions, they fail to capture all the domains of health-related quality of life. Hence, these are not preferred or commonly used measures in clinical practice. This issue is more pertinent to oncology which is a complex disease due to its natural history, primary organ involved, staging, multimodal treatment, morbidity and expected survival. As QALYs cannot be calculated from the disease specific measures like the EORTC QLQ C30, FACT-G etc., there is a need of mapping of disease specific measures onto the generic measures of utility. We intend to study this by mapping of EORTC QLQ C-30 and BR23 modules with the EQ-5D-5L and will be the subject for are upcoming publications. Moreover, as the current study is first of its kind reporting the utility scores from a large cohort of breast cancer patients seeking treatment at the country's largest cancer facility, it will guide clinicians as well as policy makers for economic evaluations in future.

An important observation was the discordance between the utility values derived based on the EQ-5D-5L and VAS. The values obtained by VAS method were lower in our data as opposed to the EQ-5D-5L value which contrasts with the finding reported by Peasgood et al., (2010), and also highlights the lower reliability of the VAS method.

Hence stand-alone use of the VAS method is generally not recommended (Torrance et al., 2001). However, we have found moderate to high correlations between utility score and VAS. The EQ-5D-5L values on the other hand are prone to lesser bias due to the inclusion of a wide range of health states that increases the sensitivity and reduces the ceiling effect that is reported for the EQ-5D-3L values (Kim et al., 2012).

Strengths and limitations

The large sample size of breast cancer patients taking treatment at a tertiary cancer centre gives the opportunity to include patients from diverse socio-economic background and different parts of the country. As all the breast cancer patients were accrued uniformly and consecutively over the study period, the convenience sampling is likely to represent the overall breast cancer population in the country. Due to lack of availability of the Indian value at the time of initiation of the study, the cancer cohort has been compared with the non-cancer cohort in order to get non-skewed data.

In this study, we haven't captured the utility values separately for the different types of treatment like surgery, chemotherapy and radiotherapy. Moreover, the side-effects, recurrence or progression states have also not been captured. The metastatic stage is also under-represented in our data.

Author Contribution Statement

TW & SKM conceptualized the research and decided the study design. SP, JM, RS, SG, VP were involved in screening of subjects and data collection, SS and PKK performed the data analysis. TW & SS were involved in writing the first draft of the manuscript. All the authors read and edited the final draft. TW & SKM provided overall supervision of the study.

Acknowledgements

Funding statement

The authors extend their deepest gratitude to the Women's Cancer Initiative, the Nag Foundation, the International Institute for Population Sciences, and the Tata Memorial Centre for providing financial support.

Availability of data

Data is not publicly available, and it may be available upon reasonable request to corresponding author. Corresponding author has all rights in sharing the data.

Ethics approval

The study has obtained approval from the institutional ethics committee of TMC and was registered on the Clinical Trial Registry of India with CTRI No CTRI/2019/07/020142 on 10/07/2019. This was an investigator initiated study.

Consent to participants

Informed written consent was obtained from all the participants included in the study.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

References

Amarsheda S, Bhise A (2021). Association of Fatigue, Quality of Life and Functional Capacity in Breast Cancer Patients Receiving Adjuvant Chemotherapy. *Asian Pac J Cancer Care*, **6**, 59-4.

Cheung YB, Luo N, Ng R, Lee CF (2014). Mapping the functional assessment of cancer therapy-breast (FACT-B) to the 5-level EuroQoL Group's 5-dimension questionnaire (EQ-5D-5L) utility index in a multi-ethnic Asian population. *Health Qual Life Outcomes*, **12**, 1-10.

Chou TC, Chiang SC, Ko Y (2020). Health state utilities for metastatic breast cancer in Taiwan. *Breast J*, **51**, 57-4.

Department of Health Research (2018). Health technology assessment in India: a manual., Health Technology Assessment in India A Manual, MOHFW, Govt of India https://htain.icmr.org.in/documents/publications/htain-manual.

Dhillon PK, Mathur P, Nandakumar A, et al (2018). The burden of cancers and their variations across the states of India: the Global Burden of Disease Study 1990–2016. *Lancet Oncol*, **19**, 1289-6.

EQ-5D-5L User Guide Basic information on how to use the EQ-5D-5L instrument (2019). EuroQol Research Foundation, The Netherlands. Retrieved April 25, 2022 from https://euroqol.org/eq-5d-instruments/eq-5d-5l-about/.

Huang W, Yang J, Liu Y, et al (2018). Assessing health-related quality of life of patients with colorectal cancer using EQ-5D-5L: a cross-sectional study in Heilongjiang of China. *BMJ Open*, **8**, e022711.

Jyani G, Chauhan AS, Rai B, et al (2020b). Health-related quality of life among cervical cancer patients in India. *Int J Gynecolo Cancer*, **30**.

Jyani G, Prinja S, Kar SS, et al (2020a). Valuing health-related quality of life among the Indian population: a protocol for the Development of an EQ-5D Value set for India using an Extended design (DEVINE) Study. *BMJ Open*, **10**, e039517.

Jyani G, Sharma A, Prinja S, et al (2022). Development of an EQ-5D value set for India using an extended design (DEVINE) study: The Indian 5-level version EQ-5D value set. *Value Health*, **25**, 1218-6.

Kim EJ, Ko SK, Kang HY (2012). Mapping the cancer-specific EORTC QLQ-C30 and EORTC QLQ-BR23 to the generic EQ-5D in metastatic breast cancer patients. *Qual Life Res*, **21**, 1193-3.

Kim SH, Jo MW, Ock M, Lee HJ, Lee JW (2017). Estimation of health state utilities in breast cancer. *Patient Prefer Adherence*, **2017**, 531-6 .

Kim SH, Kim HJ, Lee SI, Jo MW (2012). Comparing the psychometric properties of the EQ-5D-3L and EQ-5D-5L in cancer patients in Korea. *Qual Life Res*, **21**, 1065-3.

National Cancer for Disease Informatics and Research (2020). Report of National Cancer registry Programme (2012-2016). Retrieved July 18, 2022. https://ncdirindia.org/All_Reports/Report_2020/resources/Chapter7CancerBreast.pdf.

National Institute for Health and Cancer Research (2022). Health Technology Assessment. Retrieved May 29, 2022. https://www.nihr.ac.uk/explore-nihr/funding-programmes/health-technology-assessment.htm.

Peasgood T, Ward SE, Brazier J (2010). Health-state utility values in breast cancer. *Expert Rev Pharmacoecon Outcomes Res*, **10**, 553-6.

Shiroiwa T, Fukuda T, Shimozuma K, et al (2017). Long-term health status as measured by EQ-5D among patients with metastatic breast cancer: comparison of first-line oral S-1 and taxane therapies in the randomized phase III SELECT BC trial. *Qual Life Res*, **26**, 445-3.

Torrance GW, Feeny D, Furlong W (2001). Visual analog scales: do they have a role in the measurement of preferences for health states?. *Med Deci Making*, **21**, 329-4.

Vashistha V, Poulose R, Choudhari C, Kaur S, Mohan A (2019). Quality of Life among Caregivers of Lower-Income Cancer Patients: A Single-Institutional Experience in India and Comprehensive Literature Review. *Asian Pac J Cancer Care*, **4**, 87-3.

Yousefi M, Najafi S, Ghaffari S, Mahboub-Ahari A, Ghaderi H (2016). Comparison of SF-6D and EQ-5D scores in patients with breast cancer. *Iran Red Crescent Med J*, **18**.