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ORIGINAL SCIENTIFIC REPORT

# Health-Related Quality of Life Associated with Barrett's Esophagus and Cancer

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## Abstract

*Background* Research assessing health-related quality of life (HRQoL) which can be applied to economic evaluation in Barrett's esophagus (BE) and esophageal cancer is limited. This study derived health state utilities for various 'stages' of BE and Cancer.

*Methods* A cross-sectional survey was conducted, including patients with non-dysplastic BE, low-grade dysplasia, high-grade dysplasia, or esophageal adenocarcinoma. HRQoL was assessed using generic instruments—EQ-5D-5L and SF-36, and a cancer-specific instrument—EORTC QLQ-C30. Outcomes were compared for health states following different treatments. Correlations and agreements for the three instruments were investigated using Spearman's correlation coefficient ($r$) and intraclass correlation coefficient (ICC).

*Results* A total of 97 respondents (80% male, mean age 68 years) returned questionnaires. The mean (standard deviation) health state utilities for the total sample were 0.79 (0.24) for the EQ-5D-5L, 0.57 (0.29) for the SF-6D (derived from SF-36) and 0.73 (0.20) for the QLU-C10D (derived from EORTC QLQ-C30). There were strong correlations ($r > 0.80$) and absolute agreement (except EQ-5D-5L and SF-6D with an ICC of 0.69) among the three instruments. No significant differences were observed for different stages of BE or interventions. However, following surgery for cancer patients reported better psychological well-being than those under surveillance or following endoscopic treatments.

*Conclusion* HRQoL for BE surveillance and following cancer treatment was similar. Esophagectomy was associated with better psychological functioning, and this might be attributed to a reduction in the perceived risk of cancer. The correlation between the EORTC QLU-C10D and the other health state utility instruments supports the validity of this new instrument.

## Introduction

Barrett's esophagus (BE) is the recognized precursor of esophageal adenocarcinoma [1], an aggressive cancer with a poor 5-year survival rate, and an incidence which has continued to increase by 2% per year in Australia and the USA [2, 3]. The importance of assessing health-related quality of life (HRQoL) for patients with BE and patients with esophageal cancer has gained increasing attention worldwide [4]. However, empirical research to assess quality of life, especially preference-based HRQoL (or health state utility) which can be applied for economic

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evaluation and economic modeling studies in patients with BE and with esophageal cancer, is limited. Health state utility (on the 0–1 dead-full health scale) is essential for the calculation of quality-adjusted life years (QALYs) when conducting cost-utility analyses, the most prevalent form of economic evaluation internationally [5].

In a study of 50 patients aged 46–83 years from the US investigating health state utilities in patients with malignant esophageal dysphagia using three methods (direct assessment via standard gamble (SG), time trade-off (TTO) and indirect assessment via the EuroQol 5-dimensions (EQ-5D) instrument), mean utilities decreased across all three methods along with more advanced stages [6]. The utilities in patients with various BE-associated health states in the USA were further studied in a sample of 20 patients aged 49–77 years using the SG method [7]. All patients in the study had BE without dysplasia, but the other BE-associated health state utilities were evaluated based on hypothetical states. A systematic review of HRQoL in patients with BE suggests that BE is associated with a significant decrement in HRQoL as measured by both generic and disease-specific quality-of-life instruments [4].

The vast majority of studies have been conducted in the USA, and none have applied the five-level version of the EQ-5D (EQ-5D-5L) and the utility-based version of the European Organization for Research and Treatment of Cancer Quality of life Core questionnaire version 3.0 (EORTC QLQ C30), the Quality of Life Utility Measure-Core 10 dimensions (QLU-C10D). No study to date has been conducted in Australia to derive health state utility for patients with various BE-associated health states. This study aimed to fill this gap by investigating HRQoL and health utility scores for common progression states in patients with BE using two generic utility-based measures the EQ-5D-5L and the SF-6D and one disease-specific utility measure, the QLU-C10D. The Australian cohort further diversifies the data available for future health economic modeling.

## Methods

A cross-sectional survey was conducted. Potential participants were sought from two clinical administrative databases: Patients with non-dysplastic Barrett's esophagus (NDBE), low-grade dysplasia (LGD), or high-grade dysplasia (HGD) were recruited from a Barrett's Esophagus Surveillance database, which has managed the recall and scheduling of $> 1000$ patients with Barrett's esophagus from the Southern Adelaide region in South Australia (approximate population 450,000) since 2003. Patients with esophageal adenocarcinoma managed at Flinders Medical Centre were recruited from an upper gastrointestinal cancer database. Two inclusion criteria were applied: Respondents were aged $\geq 40$ years old, and were able to read and write in English for the purpose of self-completing a questionnaire. One exclusion criterion was originally considered: Those who had an esophagectomy or endoscopic ablation (e.g., endoscopic mucosal resection) treatment within the previous 12 months of the survey were excluded to minimize the impact of the early post-treatment on HRQoL. However, after examining their quality of life data and identifying no statistically significant differences for outcomes in individuals at less than 12 months follow-up, we included all respondents irrespective of length of follow-up in this study owing to the relative small sample size of the respondents.

Owing to the descriptive nature of this study, there were no formal sample size requirements for the statistical analysis [8]. Based on the previous literature, studies undertaken to generate utility measures for patients undergoing BE surveillance or with esophageal adenocarcinoma have included varied sample sizes. One study applied the EORTC in a sample of 57 patients with adenocarcinoma [9], 50 patients with malignant esophageal dysphagia were enrolled in a study using SG, TTO, and the EQ-5D to investigate health state utilities [6], and a sample of 20 patients with various BE-associated health states were recruited in a study that used the SG method [7]. Our study aimed to recruit 25 participants for each of the four sub-groups specified, and a total of 100 patients.

A hard-copy questionnaire and information sheet were sent to potential participants, and completed returned questionnaires yielded the data for this study. The questionnaire consisted of two main sections. Section A included participants' demographic characteristics, pre-existing comorbidity information, and treatment history across the previous 12 months. Section B included three HRQoL instruments: one generic preference-based HRQoL instrument, the five-level EQ-5D questionnaire (EQ-5D-5L), one generic HRQoL instrument, the 36-Item Short-Form Health Survey (SF-36), and one cancer-specific QoL instrument, the EORTC QLQ-C30.

EQ-5D-5L [10]: The five-level EQ-5D is an updated version of the world's most widely used HRQoL three-level EQ-5D (EQ-5D-3L) instrument, developed by the EuroQol Group. The EQ-5D-5L comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. By increasing the number of levels for each dimension, the EQ-5D-5L could potentially increase reliability and sensitivity and reduce ceiling effects relative to the previous three-level version [11]. An Australian-general-population-specific scoring algorithm for the EQ-5D-5L developed using a discrete choice experiment technique based on an online panel of 944 general populations was used for comparison [11].

SF-36 (Version 2.0) and SF-6D [12]: The SF-36 is the most widely used generic non-preference-based HRQoL instrument. The 36 items can be grouped into eight subscales and two component summary scores (a physical component summary (PCS) and mental component summary (MCS)). The SF-6D is a preference-based instrument that is derived from the SF-36 [12]. An Australian-specific scoring algorithm developed using a discrete choice experiment technique based on an online panel of 1017 respondents from the general population was used for comparison of the SF-6D data [13].

EORTC QLQ-C30 and QLU-C10D [14, 15]: The EORTC QLQ-C30 represents one of the most widely used cancer-specific QoL instruments. The QLQ-C30 contains 30 items covering the most common cancer symptoms and functions. It has five multi-item functional scales, three multi-item symptom scales, six individual items concerning common symptoms in cancer patients, and two questions assessing global health status/overall quality of life. Recently, a new cancer-specific preference-based instrument QLU-C10D has been developed based on responses from the QLQ-C30; an Australian general population scoring algorithm developed using a discrete choice experiment technique from an online panel of 1856 participants was used for comparison in this study [16].

### Data analysis

Demographic and treatment characteristics of the study sample were summarized using the number and percentage for categorical variables and the means and standard deviations (SD) for continuous variables as well as the medians and interquartile ranges (IQR). Descriptive statistics to summarize the quality of life scores of the entire sample and by diagnosis (NDBE, LGD, HGD, and cancer) as well as interventions (surveillance, endoscopic treatment and surgery) were generated. Bivariate analysis was conducted to assess the relationship between quality of life and the diagnosis/interventions using statistical tests of difference between groups (the Wilcoxon rank sum or Mann–Whitney $U$ test for two-group analysis and the Kruskal–Wallis tests for more than two groups). The strengths of correlation and absolute agreement between each of the two health state utilities were investigated using the Spearman's correlation and the intraclass correlation coefficients (ICCs) (with an ICC $> 0.7$ indicating a strong agreement) [17]. A Bland–Altman plot [18] which allows visual determination of the agreement between the newly developed QLU-C10D and the other two classical health state utility instruments is also presented. The criterion for statistical significance was assumed at a threshold of 5% ($P < 0.05$). Data were analyzed using Stata version 14 [19]. This study was approved by the Southern Adelaide Clinical Human Research Ethics Committee (Reference No. 492.14-HREC/14/SAC/511).

## Results

### Respondents' characteristics

A total of 177 people from the Barrett's esophagus database, and 44 patients with esophageal adenocarcinoma, were identified as meeting the inclusion criteria and invited to participate in this study. Among them, three people from the Barrett's esophagus database were deceased and 11 identified from the cancer database were not contactable by mail (e.g., address changed) at the time of the survey. In total, 74 surveys were returned from the Barrett's esophagus cohort (NDBE = 37; LGD = 15, and HGD = 22) and 23 from the esophageal adenocarcinoma cohort, with an overall response rate of 46.4%. Mean (range) age of the sample was 68 (43–90) years, 80% were male, and 64% reported themselves as ex-smokers. Among them, 23 patients had undergone esophagectomy, including 18 patients diagnosed with cancer, and five patients with HGD; the remaining five cancer patients either declined surgery or were not fit enough to undergo operation. All patients diagnosed with cancer who underwent esophagectomy received neoadjuvant chemoradiotherapy before surgery. The mean time from surgery to completion of the questionnaire was 25 months. Respondents with HGD (who did not receive surgery) were treated endoscopically; they were analyzed as the endoscopic treatment group. Table 1 summarizes the characteristics of the study sample.

### Quality of life assessment

The mean (SD) health state utility scores for the whole sample was 0.79 (0.24) according to the EQ-5D-5L, 0.57 (0.29) according to the SF-6D, and 0.73 (0.20) for the QLU-C10D (Table 2), and there were strong correlations (all $r > 0.8$) and absolute agreements (except EQ-5D-5L and SF-6D with an ICC of 0.69) among the three health state utilities (Table 3). Figure 1 presents Bland–Altman plots for the newly developed QLU-C10D vs EQ-5D-5L/SF-6D instruments. The limits of agreement (LoA) (which is defined as the mean difference $\pm$ 1.96 SD of differences) of EQ-5D-5L and QLU-C10D ranged between $-0.198$ and 0.336, while the LoA of SF-6D and QLU-C10D ranged between $-0.510$ and 0.187.

**Table 1** Patient characteristics

| Characteristics | *N* (%)/mean (SD)* |
|---|---|
| Age (years)[a] | 67.8 (10.7) |
| Gender: male | 78 (80%) |
| Born in Australia | 64 (66%) |
| Smoking status | |
| Smoker | 10 (11%) |
| Ex-smoker | 61 (64%) |
| Never smoked | 24 (25%) |
| Comorbidities | |
| Heart | 12 (12%) |
| Respiratory | 12 (12%) |
| Diabetes | 18 (19%) |
| Renal | 2 (2%) |
| Obesity | 11 (11%) |
| Reflux | 52 (54%) |
| Other comorbidities | 19 (20%) |
| Treatment characteristics | |
| Oesophagectomy | 23 (24%) |
| Chemotherapy | 19 (20%) |
| Radiotherapy | 15 (15%) |
| Palliative care | 4 (4%) |
| Radio-frequency ablation | 3 (3%) |
| Endoscopic mucosal resection | 12 (12%) |
| Argon plasma coagulation | 5 (5%) |
| Time post-endoscopic treatment (months)* | 28.9 (34.5) |
| Time under surveillance (months)* | 73.4 (40.1) |
| Time after surgery (months)* | 25 (25.7) |

[a]The full sample includes respondents with non-dysplastic Barrett's esophagus ($N = 37$), low-grade dysplasia ($N = 15$), high-grade dysplasia ($N = 22$), and cancer ($N = 23$)

**SD* standard deviation

### Quality of life scores in sub-groups

When differentiated by stage of disease, consistently lower scores on all instruments were observed for respondents with HGD than the other disease states but this difference was not statistically significant (see Table 2 for more details). Examining the quality of life scores for respondents with and without a diagnosis of cancer, the results indicated higher scores for respondents who had received a cancer diagnosis on all instruments (except for SF-36 PCS), although these differences were not statistically significant except for the mental health component of the SF-36 ($P = 0.041$). When differentiated by type of intervention received (i.e., surveillance, endoscopic treatment or surgery), there were no statistically significant differences observed (see Table 4 for details).

## Discussion

This study evaluated HRQoL in patients with BE and esophageal adenocarcinoma in Australia from a health economics perspective. Compared to other studies conducted among patients with BE and applying the SF-36, lower scores, both component and dimension scores, were observed in our study population [20, 21]. This might be attributed to more advanced age in our study (68 years compared to 65 and 57 in the previous two studies), or different managements of gastroesophageal reflux-21% in the second study had undergone anti-reflux surgery [21]. However, similar to other studies [21, 22], we demonstrated high levels of psychosocial symptoms such as anxiety and depression among patients under endoscopy surveillance. This has been attributed to the psychological distress associated with living with a pre-malignant condition, coupled with the burden of endoscopic surveillance and treatment [4, 20, 21]. In patients with a diagnosis of dysplastic BE, a perceived higher risk of cancer and potential future treatment might also contribute to impaired HRQoL and high levels of depression, worry, and stress [23].

When compared to patients under surveillance (Table 4), respondents with cancer reported better HRQoL on the psychological well-being dimensions for all instruments (details not shown): EQ-5D-5L (anxiety/depression), SF-6D (mental health), SF-36 (mental health), and QLQ-C30 (emotional functioning and cognitive functioning). It is important to note here that over 75% of respondents diagnosed with cancer underwent esophagectomy. Scarpa et al. [24] have attributed the improved emotional and mental health after esophagectomy to the relief of surviving cancer, and perhaps the surgery, which can represent a 'near-death experience.' Considering the high levels of depression associated with the perceived risk of cancer among patients under surveillance and the fear of cancer recurrence after endoscopic treatment, it might be argued that surgery is associated with a reduced perceived risk/fear of cancer, and that this results in better psychological functioning in the post-surgical patients [4, 20, 21, 23, 25]. However, it can also be argued that prior to surgery patients had adapted to a very poor quality of life and hence recalibrated and reconceptualized their quality of life through a reprioritization of their personal values, a concept also referred to as 'response shift' [26–30].

Previous studies applying the EORTC QLQ-C30 to assess HRQoL after esophagectomy have demonstrated reduced quality of life in the short term and varied results in the long term. Changes in quality of life are a result of reduced functioning and increased symptoms as well as complications associated with the physiological and

**Table 2** Descriptive statistics on health utility and quality of life by disease stage

| Instruments | | All | Stage of disease | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | NDBE | LGD | HGD | Non-cancer | Cancer | *P* value* |
| *Panel A: Health utility scores* | | | | | | | | |
| SF-6D | Mean (SD) | 0.57 (0.29) | 0.53 (0.34) | 0.69 (0.21) | 0.50 (0.29) | 0.55 (0.31) | 0.62 (0.25) | 0.436 |
| | *N* | 85 | 32 | 14 | 18 | 64 | 21 | |
| EQ-5D-5L | Mean (SD) | 0.79 (0.24) | 0.77 (0.29) | 0.88 (0.15) | 0.73 (0.26) | 0.78 (0.26) | 0.82 (0.18) | 0.804 |
| | N | 92 | 34 | 15 | 21 | 70 | 22 | |
| QLU-C10D | Mean (SD) | 0.73 (0.20) | 0.73 (0.20) | 0.78 (0.16) | 0.69 (0.26) | 0.73 (0.21) | 0.75 (0.17) | 0.996 |
| | *N* | 94 | 36 | 15 | 21 | 72 | 22 | |
| *Panel B: Quality of life (QoL) scores* | | | | | | | | |
| SF-36 PCS | Mean (SD) | 44.59 (11.32) | 45.75 (12.17) | 46.51 (8.98) | 42.45 (11.56) | 44.94 (11.36) | 43.52 (11.38) | 0.632 |
| | *N* | 94 | 35 | 15 | 21 | 71 | 23 | |
| SF-36 MCS | Mean (SD) | 50.91 (11.72) | 47.73 (13.07) | 52.04 (11.06) | 50.36 (12.21) | 49.42 (12.38) | 55.51 (7.97) | 0.041 |
| | *N* | 94 | 35 | 15 | 21 | 71 | 23 | |
| QLQ-C30 summary score | Mean (SD) | 79.74 (16.23) | 78.94 (15.11) | 82.63 (16.27) | 75.18 (21.30) | 78.57 (17.34) | 83.50 (11.50) | 0.355 |
| | *N* | 97 | 37 | 15 | 22 | 74 | 23 | |
| Global QoL | Mean (SD) | 69.50 (23.69) | 68.02 (24.65) | 72.78 (27.00) | 63.64 (26.17) | 67.68 (25.43) | 75.36 (15.99) | 0.289 |
| | *N* | 97 | 37 | 15 | 22 | 74 | 23 | |

*NDBE* non-dysplastic Barrett's esophagus, *LGD* low-grade dysplasia, *HGD* high-grade dysplasia, *PCS* physical component score, *MCS* mental component score, *QLQ* EORTC Quality of Life Questionnaire, *SD* standard deviation

* *P* values for differences between non-cancer and cancer based on Wilcoxon rank sum test statistics. Non-cancer includes NDBE, LGD, and HGD

**Table 3** Correlations and absolute agreements between three health state utility measures

| Instrument | EQ-5D-5L | SF-6D | QLU-C10D |
|---|---|---|---|
| EQ-5D-5L | 1 | 0.694 | 0.869 |
| SF-6D | 0.803 | 1 | 0.751 |
| QLU-C10D | 0.843 | 0.813 | 1 |

Spearman's correlation coefficients reported in the bottom left, and the intraclass correlation coefficients reported in the top right. All correlations were statistically significant ($P < 0.01$)

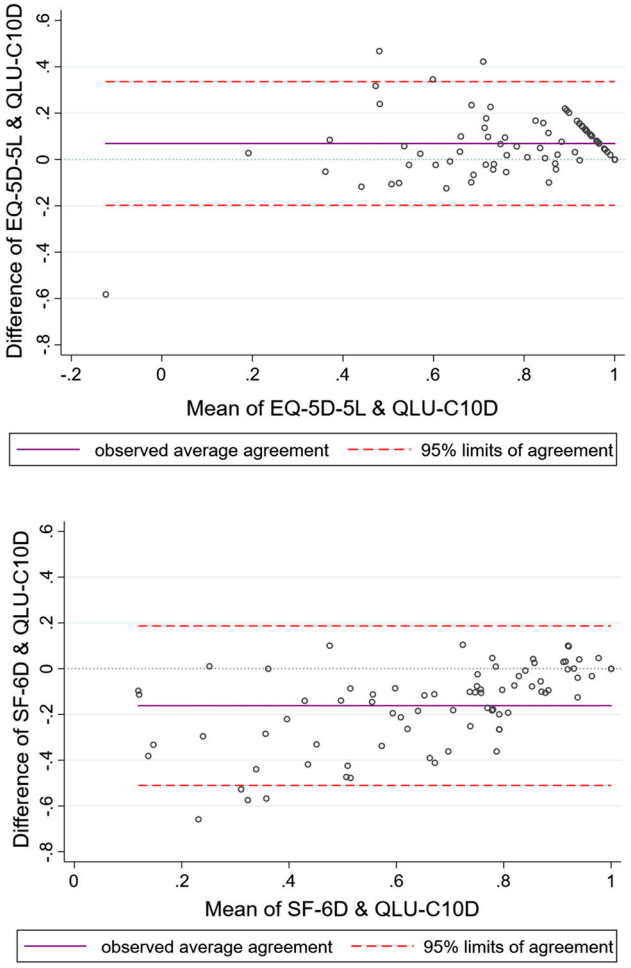


**Fig. 1** Bland–Altman plots between QLU-C10D and EQ-5D-5L/SF-6D utilities

anatomical changes in the alimentary tract following surgery. Global quality of life has been observed to decline in the first 6 months after surgery [31, 32] with a nadir at 2 months [33] or 3 months [34, 35]. Mixed results are reported 1 year after esophagectomy. Some studies show a significant reduction in global quality of life [36, 37], while other studies demonstrated quality of life in the absence of comorbidity that is comparable to baseline or that of the general population [38, 39], although worse outcomes on some functional (physical, role functioning, and social functioning) and symptom scales (fatigue, dyspnoea, diarrhea, constipation) may still exist [31, 34, 40]. Quality-of-life improvement with minimal functional and symptom detriments was also observed among patients who survived at least 21 months after surgery [41]. Studies undertaken three or more years after esophagectomy reveal restoration of quality of life that is comparable to the general population [42, 43]. The global quality of life score observed in our study is comparable to studies undertaken in similar patients (receiving neoadjuvant treatment followed by surgery) at least 1 year post-surgery (average time after surgery in our study population was 25 months with median of 16 months).

This study also investigated the comparability of three instruments for eliciting health state utilities from patients with various stages of BE (Table 2). It is also one of the first to apply the newly developed QLU-C10D in this population. The magnitude of utilities differed depending on which instrument was used. In this sample, the mean utility was the highest for the EQ-5D-5L, followed by QLU-C10D, and the lowest for the SF-6D, with a mean difference of 0.23 between the EQ-5D and the SF-6D. There were high correlations among all three instruments, while for the absolute agreement, strong agreements were found between EQ-5D-5L and QLU-C10D (ICC = 0.87), and between SF-6D and QLU-C10D (ICC = 0.75). This strong correlation and absolute agreement between the newly developed EORTC QLU-C10D measure and the other two widely used preference-based quality of life instruments support the validity of this new disease-specific health state utility instrument. This result also suggests that the new QLU-C10D instrument might potentially be used in other populations, although further evidence is required before a solid conclusion can be made. The Bland–Altman plots between QLU-C10D and EQ-5D-5L/SF-6D also indicated a high level of correlation/agreement, although the limits of agreement of each pair of instruments in the comparisons were wide (0.534 and 0.697, respectively) and likely to exceed the minimum clinically important difference for the health state utility instrument [44]; and for this reason, the instruments should not be used interchangeably. The findings from our study help to provide validity to apply these health state utility measures for completing future cost-utility analyses in this population. Although comparisons of previous international studies have been provided above, it is not possible to directly compare the utilities reported in this study to the previous literature in Australia since this is the first Australian study that has been conducted.

**Table 4** Descriptive statistics on health utility and quality of life by interventions

| Instrument | | Interventions | | | | | |
|---|---|---|---|---|---|---|---|
| | | Surveillance | Endoscopic treatment | Cancer no surgery | Non-surgical | Surgery | *P*-value* |
| *Panel A: Health utility scores* | | | | | | | |
| SF-6D | Mean (SD) | 0.58 (0.31) | 0.54 (0.30) | 0.52 (0.31) | 0.57 (0.30) | 0.57 (0.27) | 0.988 |
| | *N* | 50 | 10 | 4 | 64 | 21 | |
| EQ-5D-5L | Mean (SD) | 0.80 (0.26) | 0.72 (0.31) | 0.81 (0.28) | 0.79 (0.27) | 0.81 (0.15) | 0.539 |
| | *N* | 53 | 12 | 5 | 70 | 22 | |
| QLU-C10D | Mean (SD) | 0.74 (0.20) | 0.72 (0.29) | 0.75 (0.21) | 0.74 (0.21) | 0.72 (0.17) | 0.346 |
| | *N* | 56 | 11 | 5 | 72 | 22 | |
| *Panel B: Quality of life (QoL) scores* | | | | | | | |
| SF-36 PCS | Mean (SD) | 45.90 (10.95) | 42.05 (14.65) | 40.15 (9.22) | 44.90 (11.48) | 43.63 (10.99) | 0.613 |
| | *N* | 55 | 11 | 5 | 71 | 23 | |
| SF-36 MCS | Mean (SD) | 48.51 (13.28) | 55.20 (7.73) | 51.31 (10.76) | 49.74 (12.54) | 54.52 (7.89) | 0.189 |
| | *N* | 55 | 11 | 5 | 71 | 23 | |
| QLQ-C30 summary score | Mean (SD) | 79.63 (16.28) | 77.79 (22.93) | 80.59 (15.25) | 79.40 (17.20) | 80.85 (12.89) | 0.973 |
| | *N* | 57 | 12 | 5 | 74 | 23 | |
| Global QoL | Mean (SD) | 68.57 (25.78) | 72.92 (23.33) | 68.33 (12.36) | 69.26 (24.56) | 70.29 (21.15) | 0.976 |
| | *N* | 57 | 12 | 5 | 74 | 23 | |

*PCS* physical component score, *MCS* mental component score, *QLQ* EORTC quality of life questionnaire, *SD* standard deviation

**P* values for differences between non-surgical versus surgical interventions based on Wilcoxon rank sum test statistics. Non-surgical includes surveillance, endoscopic treatment, and cancer no surgery

This study is not without limitations. A key limitation is the relatively low response rate and small sample size. In particular, we were not able to investigate the long-term utilities for cancer survivors, or to explore the impact of different cancer stages, or the time post-treatment and post-surgery on quality of life. Although on average cancer patients after treatment had a similar quality of life to those under surveillance for BE, there could be a chance that those with more advanced cancer (i.e., in stage III or IV) will have a permanent lower quality of life. A larger sample size would facilitate investigation of independent effects of the above factors using a regression analysis. Future studies involving larger sample sizes for BE and esophageal adenocarcinoma in Australia and internationally are needed to underpin longitudinal assessment of quality of life over time and to facilitate health economic studies which seek to evaluate quality-adjusted life year outcomes. There could also be a potential selection bias in the participants' recruitment; however, since this was an anonymous survey we were not able to compare characteristics between those who participated in the survey vs those who opted not to participate.

## Conclusion

HRQoL for patients under surveillance for BE and following surgical treatment of cancer was similar. However, esophagectomy was associated with better post-treatment psychological functioning. This might be due to a reduction in the perceived risk of cancer following surgery. A strong correlation and absolute agreement was observed between the newly developed EORTC QLU-C10D and two widely used preference-based quality of life instruments, providing evidence to support the validity of this new disease-specific health state utility instrument.

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**Compliance with ethical standards**

**Conflict of interest** There are no competing interests or conflicts of interests to disclose among the authors.

## References

1. Solaymani-Dodaran M, Logan RFA, West J et al (2004) Risk of oesophageal cancer in Barrett's oesophagus and gastro-oesophageal reflux. Gut 53:1070–1074
2. Stavrou EP, McElroy HJ, Baker DF et al (2009) Adenocarcinoma of the oesophagus: incidence and survival rates in New South Wales, 1972–2005. Med J Aust 191:310–314
3. Thrift AP, Whiteman DC (2012) The incidence of esophageal adenocarcinoma continues to rise: analysis of period and birth cohort effects on recent trends. Ann Oncol 23:3155–3162
4. Crockett SD, Lippmann QK, Dellon ES et al (2009) Health-related quality of life in patients with Barrett's esophagus: a systematic review. Clin Gastroenterol Hepatol 7:613–623
5. Brazier J, Ratcliffe J, Salomon JA, Tsuchiya A (2016) Measuring and valuing health benefits for economic evaluation. Oxford University Press, Oxford
6. Wildi SM, Cox MH, Clark LL et al (2004) Assessment of health state utilities and quality of life in patients with malignant esophageal dysphagia. Am J Gastroenterol 99:1044–1049
7. Hur C, Wittenberg E, Nishioka NS et al (2006) Quality of life in patients with various Barrett's esophagus associated health states. Health Qual Life Outcomes 4:45
8. Stein D, Joulain F, Naoshy S et al (2014) Assessing health-state utility values in patients with metastatic colorectal cancer: a utility study in the United Kingdom and the Netherlands. Int J Colorectal Dis 29:1203–1210
9. Blazeby JM, Kavadas V, Vickery CW et al (2005) A prospective comparison of quality of life measures for patients with esophageal cancer. Qual Life Res 14:387–393
10. van Reenen M, Janssen B (2015) EQ-5D-5L User guide—basic information on how to use the EQ-5D-5L instrument. EuroQol Research Foundation, Rotterdam
11. Norman R, Cronin P, Viney R (2013) A pilot discrete choice experiment to explore preferences for EQ-5D-5L health states. Appl health econ health policy 11:287–298
12. Brazier J, Roberts J, Deverill M (2002) The estimation of a preference-based measure of health from the SF-36. J health econ 21:271–292
13. Norman R, Viney R, Brazier J et al (2014) Valuing SF-6D health states using a discrete choice experiment. Med Decis Mak Int J Soc Med Decis Mak 34:773–786
14. Aaronson NK, Ahmedzai S, Bergman B et al (1993) The European organization for research and treatment of cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst 85:365–376
15. King MT, Costa DSJ, Aaronson NK et al (2016) QLU-C10D: a health state classification system for a multi-attribute utility measure based on the EORTC QLQ-C30. Qual Life Res 25:625–636
16. King MT, Viney R, Simon Pickard A et al (2018) Australian utility weights for the EORTC QLU-C10D, a multi-attribute utility instrument derived from the cancer-specific quality of life questionnaire, EORTC QLQ-C30. PharmacoEconomics 36:225–238
17. Fayers PM, Machin D (2016) Quality of life: the assessment, analysis and interpretation of patient-reported outcomes. Wiley, Chichester
18. Bland JM, Altman DG (1986) Statistical methods for assessing agreement between two methods of clinical measurement. Lancet (London, England) 1:307–310
19. StataCorp (2015) Stata Statistical Software: Release 14. College Station, Texas

20. Gerson LB, Ullah N, Hastie T et al (2007) Does cancer risk affect health-related quality of life in patients with Barrett's esophagus? Gastrointest Endosc 65:16–25
21. Lippmann QK, Crockett SD, Dellon ES et al (2009) Quality of life in GERD and Barrett's esophagus is related to gender and manifestation of disease. Am J Gastroenterol 104:2695–2703
22. Essink-Bot M-L, Kruijshaar ME, Bac DJ et al (2007) Different perceptions of the burden of upper GI endoscopy: an empirical study in three patient groups. Qual Life Res 16:1309–1318
23. Shaheen NJ, Peery AF, Hawes RH et al (2010) Quality of life following radiofrequency ablation of dysplastic Barrett's esophagus. Endoscopy 42:790–799
24. Scarpa M, Valente S, Alfieri R et al (2011) Systematic review of health-related quality of life after esophagectomy for esophageal cancer. World J Gastroenterol 17:4660–4674
25. Rosmolen WD, Boer KR, de Leeuw RJ et al (2010) Quality of life and fear of cancer recurrence after endoscopic and surgical treatment for early neoplasia in Barrett's esophagus. Endoscopy 42:525–531
26. Breetvelt IS, Van Dam FSAM (1991) Underreporting by cancer patients: the case of response-shift. Soc Sci Med 32:981–987
27. Sprangers MAG, Schwartz CE (1999) The challenge of response shift for quality-of-life-based clinical oncology research. Ann Oncol 10:747–749
28. Aburub AS, Gagnon B, Ahmed S et al (2018) Impact of reconceptualization response shift on rating of quality of life over time among people with advanced cancer. Support Care Cancer 26:3063–3071
29. Jansen SJ, Stiggelbout AM, Nooij MA et al (2000) Response shift in quality of life measurement in early-stage breast cancer patients undergoing radiotherapy. Qual Life Res 9:603–615
30. Rees J, Clarke MG, Waldron D et al (2005) The measurement of response shift in patients with advanced prostate cancer and their partners. Health Qual Life Outcomes 3:21
31. Scarpa M, Saadeh LM, Fasolo A et al (2013) Health-related quality of life in patients with oesophageal cancer: analysis at different steps of the treatment pathway. J Gastrointest Surg 17:421–433
32. Barbour AP, Lagergren P, Hughes R et al (2008) Health-related quality of life among patients with adenocarcinoma of the gastro-oesophageal junction treated by gastrectomy or oesophagectomy. Br J Surg 95:80–84
33. Malmstrom M, Klefsgard R, Ivarsson B et al (2015) Quality of life measurements as an indicator for timing of support after oesophagectomy for cancer: a prospective study. BMC Health Serv Res 15:96
34. Nafteux P, Durnez J, Moons J et al (2013) Assessing the relationships between health-related quality of life and postoperative length of hospital stay after oesophagectomy for cancer of the oesophagus and the gastro-oesophageal junction. Eur J Cardiothorac Surg 44:525–533
35. Haj Mohammad N, De Rooij S, Hulshof M et al (2016) Activities of daily living and quality of life during treatment with neoadjuvant chemoradiotherapy and after surgery in patients with esophageal cancer. J Surg Oncol 114:684–690
36. Donohoe CL, McGillycuddy E, Reynolds JV (2011) Long-term health-related quality of life for disease-free esophageal cancer patients. World J Surg 35:1853–1860
37. Fuchs H, Holscher AH, Leers J et al (2016) Long-term quality of life after surgery for adenocarcinoma of the esophagogastric junction: extended gastrectomy or transthoracic esophagectomy? Gastric Cancer 19:312–317
38. Gutschow CA, Holscher AH, Leers J et al (2013) Health-related quality of life after Ivor Lewis esophagectomy. Langenbecks Arch Surg 398:231–237
39. van Meerten E, van der Gaast A, Looman CW et al (2008) Quality of life during neoadjuvant treatment and after surgery for resectable esophageal carcinoma. Int J Radiat Oncol Biol Phys 71:160–166
40. Akkerman RD, Haverkamp L, van Rossum PS et al (2015) Long-term quality of life after oesophagectomy with gastric conduit interposition for cancer. Eur J Cancer 51:1538–1545
41. Daster S, Soysal SD, Stoll L et al (2014) Long-term quality of life after Ivor Lewis esophagectomy for esophageal cancer. World J Surg 38:2345–2351
42. Derogar M, Lagergren P (2012) Health-related quality of life among 5-year survivors of esophageal cancer surgery: a prospective population-based study. J Clin Oncol 30:413–418
43. Wormald JC, Bennett J, van Leuven M et al (2016) Does the site of anastomosis for esophagectomy affect long-term quality of life? Dis Esophagus 29:93–98
44. Li S, Wang M, Liu L, et al (2018) Which approach is better in eliciting health state utilities from breast cancer patients? evidence from mainland China. Eur J Cancer Care. https://doi.org/10.1111/ecc.12965