Assessment of patients’ preferences for new anticancer drugs in China: a best–worst discrete choice experiment on three common cancer types

Zhe Feng, Jingyi Meng, Yanjun Sun, Tongling Xie, Wenzhang Lu, Guohua Wang, Jinsong Geng

ABSTRACT

Objectives Despite the advancement in anticancer drug therapies, cancer treatment decisions are often complex and preference-sensitive, making them well suited for studying shared decision-making (SDM). Our study aimed to assess preferences for new anticancer drugs among three common types of patients with cancer to inform SDM.

Design We identified five attributes of new anticancer drugs and used a Bayesian-efficient design to generate choice sets for a best–worst discrete choice experiment (BWDC). The mixed logit regression model was applied to estimate patient-reported preferences for each attribute. The interaction model was used to investigate preference heterogeneity.

Setting The BWDC was conducted in Jiangsu province and Hebei province in China.

Participants Patients aged 18 years or older, who had a definite diagnosis of lung cancer, breast cancer or colorectal cancer were recruited.

Results Data from 468 patients were available for analysis. On average, the most valued attribute was the improvement in health-related quality of life (HRQoL) (p<0.001). The low incidence of severe to life-threatening side effects, prolonged progression-free survival and the low incidence of mild to moderate side effects were also positive predictors of patients’ preferences (p<0.001). Out-of-pocket cost was a negative predictor of their preferences (p<0.001). According to subgroup analysis by type of cancer, the improvement in HRQoL remained the most valuable attribute. However, the relative importance of other attributes varied by type of cancer. Whether patients were newly diagnosed or previously diagnosed cancer cases played a dominant role in the preference heterogeneity within each subgroup.

Conclusions Our study can assist in the implementation of SDM by providing evidence on patients’ preferences for new anticancer drugs. Patients should be informed of the multiattribute values of new drugs and encouraged to make decisions reflecting their values.

INTRODUCTION

Cancer is a major global public health problem and a leading cause of death worldwide. It has also become a substantial challenge to the health of the Chinese people. In 2020, there were 4568754 new cancer cases and 3002899 cancer-related deaths in China, and cancer deaths accounted for approximately 24% of all-cause mortality.1,2 Meanwhile, the cancer spectrum in China is changing, with a rapid rise in the incidence and burden of lung, breast and colorectal cancer.3 Lung cancer is the most common cancer type and the leading cause of cancer death in China, and breast cancer has become the most common cancer type among women.4,5 The high burden of cancer requires effective actions to improve the quality of care.

In recent years, molecular targeted therapies and other innovative anticancer drugs offer hopes for patients with cancer. The accessibility of new anticancer drugs has improved significantly since the Chinese government expanded regulatory capacity and initiated a series of programmes to
accelerate the development, review, approval and reimbursement of new drugs.\(^6\)\(^7\) Despite advances in therapeutic strategies and drug availability, cancer treatment involves uncertainties and risks, as well as high out-of-pocket costs.\(^8\)\(^9\) Clinical decisions for both clinicians and patients on new anticancer drugs are often stressful or even conflicting. Studies with an improved design are warranted to generate more robust evidence to support decision-making.\(^10\)

Shared decision-making (SDM) is part of a broader concept of patient-centred care, identified by the Institute of Medicine as one of the key elements to achieve high-quality healthcare.\(^11\) Engaging patients with cancer in their treatment decisions has received increased attention. Patients would benefit from clinicians’ efforts to identify their preferences, encourage an active role in decision-making, and tailor decisions to desired choices.\(^12\)\(^13\) Furthermore, patients who are more involved in clinical decisions are more likely to experience satisfaction with treatment strategies, which leads to better clinical outcomes.\(^14\)\(^15\)\(^16\) Currently, advances in new anticancer drugs result in multiple therapeutic options. Therefore, engagement in SDM is more meaningful than ever. However, essential elements of the SDM process would be unexperienced without assessing patients’ preferences.\(^17\)\(^18\)

Best–worst scaling (BWS) has been used as a tool to elicit patients’ preferences for healthcare services, including cancer treatment. There are three types of BWS, which differ according to the complexity of the options under consideration: object case (case 1), profile case (case 2) and multiprofile case (also known as best–worst discrete choice experiment, BWDCE or case 3). Compared with the traditional DCE, the BWDCE provides larger amounts of data and richer information on respondents’ preferences among alternatives.\(^19\)\(^20\) Moreover, the utility of a single level of an attribute in BWDCE acts as a benchmark and not the entire scenario, allowing participants to determine the impact of the attribute level.\(^21\)

There is an increasing focus on preference heterogeneity, as the preferences of respondents on average can be of limited value and threaten the generalisability of study findings.\(^21\)\(^22\) Nevertheless, little is known about variations in preferences for new anticancer drugs among patients with common types of cancer. Meanwhile, a few studies only involved attributes belonging to a specific domain of anticancer therapies or lacked the attributes of patient-reported outcomes. Consequently, clinicians would find difficulty in making clinical decisions based on fragmented evidence of patients’ preferences.

To address the evidence gap, we conducted a BWDCE study to investigate patients’ preferences for new anticancer drugs. A comparative analysis was performed to identify variations in preferences among three common types of patients with cancer (ie, lung cancer, breast cancer and colorectal cancer). Preference heterogeneity was also observed within each type of patient with cancer. Our findings will provide evidence to inform SDM in clinical practice.

**METHODS**

**Identification of attributes and levels**

We took a three-step approach to define the attributes and levels of new anticancer drugs. First, a literature review on value assessment frameworks for anticancer therapies was performed to identify potential domains of attributes. Details of the domains included in the frameworks are shown in online supplemental appendix 1. A literature review of attributes and levels regarding anticancer therapies in preference-based studies was also conducted to further determine the attributes. The attributes and levels in the included studies are shown in online supplemental appendix 2.

Second, since the universe of attributes was vast, we consulted five oncology experts to further determine the attributes. To define the levels of attributes regarding health benefits and side effects, we searched the widely used health technology assessment (HTA) databases established by the National Institute for Health and Care Excellence, and the Canadian Agency for Drugs and Technologies in Health. Then we identified HTA reports of new drugs to treat lung cancer, breast cancer and colorectal cancer. We found 68 reports that had been published before 4 December 2021, and extracted the outcome data. The new drugs in the included HTA reports consisted of targeted drugs, chemotherapy drugs and immunosuppressants. The out-of-pocket cost was derived mainly from prior studies on anticancer drugs in China.

Finally, a pilot survey was conducted to provide feedback on the acceptability and intelligibility of the questionnaire. Patient responses led to a more comprehensible statement of survey questions. The attributes and levels in our BWDCE are listed in table 1, with a detailed explanation in online supplemental appendix 3.

In this study, we defined new anticancer drugs as drugs that have been marketed in China for the treatment of cancer in the last 5 years. However, the new drugs have not yet been widely used in clinical practice. Therefore, patients who indicated the use of new anticancer drugs were still receiving traditional treatment options. Considering the homogeneity of outcome measures in clinical trials of anticancer drugs and the generalisability of our potential findings, we did not limit the categories of drugs, for example, targeted therapy, chemotherapy and immunotherapy.

**Experimental design and development of the questionnaire**

A Bayesian-efficient design was applied to generate choice sets for the BWDCE. Since random combinations of attributes and levels result in too many possible scenarios, we used maximising D-efficiency to simplify the scenario settings. Our study employed Ngene V.1.2 software (Choice-Metrics, Sydney, Australia) to design choice
Table 1  Attributes and levels in the best–worst discrete choice experiment

<table>
<thead>
<tr>
<th>Domains</th>
<th>Attributes</th>
<th>Levels</th>
<th>Variables’ coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival outcomes</td>
<td>PFS</td>
<td>6 months; 12 months; 24 months</td>
<td>Categorical</td>
</tr>
<tr>
<td>Patient-reported outcomes</td>
<td>Change in HRQoL</td>
<td>Even worse; Slight improvement; Significant improvement</td>
<td>Categorical</td>
</tr>
<tr>
<td>Safety</td>
<td>Incidence of severe to life-threatening side effects</td>
<td>60%, 30%, 10%</td>
<td>Categorical</td>
</tr>
<tr>
<td></td>
<td>Incidence of mild to moderate side effects</td>
<td>90%, 50%, 10%</td>
<td>Categorical</td>
</tr>
<tr>
<td>Affordability</td>
<td>Out-of-pocket costs per month</td>
<td>CNY2000–CNY32000</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

The average exchange rate between US dollars and the CNY from July 2021 to June 2022 was 1:6.46. CNY2000 was approximately US$309.60 and CNY32 000 was about US$4953.56.

sets, which consisted of 24 settings. We used blocking techniques to evenly distribute 24 scenarios into 4 blocks, each containing 6 choice sets, thus reducing the cognitive burden of the respondents. An example of the questionnaire is shown in online supplemental appendix 4.

The questionnaire consisted of three parts. The first part included the demographic characteristics of the patients and their attitudes towards SDM. Patients responded to two closed-ended questions that included ‘I am willing to actively participate in the SDM of anticancer treatment’ and ‘I am willing to know the value of new anticancer drugs with the help of decision-aids that provide scientific evidence.’ A 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was used as the assessment method. The second part contained BWDCE tasks and the patient understanding when making BWDCE choices. Patients were asked to rate their ability of understanding on a scale from 0 to 10 in completing the choice tasks. To ensure the validity of the data, we excluded questionnaires with a score of less than 8. The third part was information on the medical history of the patients and their clinical symptoms. The first and second parts were fulfilled by patients, and the third part was completed by interviewers using records from the hospital information system.

Sample size
We used an ad hoc sample size calculation method proposed by Johnson and Orme:  

\[ \frac{na}{t} \geq 500 \]

where \( n \) is the number of respondents, \( t \) is the number of tasks, \( a \) is the number of alternatives per task and \( c \) is the number of analysis cells. Therefore, the minimum sample size is 112. There were three common types of cancer in our study, so we increased the sample size to ensure the validity of the subgroup analysis.

BWDCE implementation and data collection
Our BWDCE was conducted from 4 January 2022 to 1 May 2022. We enrolled patients 18 years of age or older who had a definite diagnosis of lung cancer, breast cancer or colorectal cancer. Patients with one of the three types of cancer were included, mainly due to the high prevalence and overwhelming burden of the disease in China. The patients in our study were recruited from Jiangsu province (ie, two hospitals in Nantong and one hospital in Yancheng) and Hebei province (ie, one hospital in Shijiazhuang). The sample size within each sampling hospital was balanced. We required the hospitals to include an equal number of patients among the three types of cancer and enrol patients with cancer consecutively.

The BWDCE survey was conducted through one-on-one, face-to-face interviews to ensure validity and reliability. Interviewers comprised 11 medical interns and 14 clinicians who had medical knowledge and were able to understand and explain our questionnaires. We developed training manuals before the formal survey. The interviewers were trained face to face or online. We required them to check the completeness of each questionnaire immediately to detect missing information. For patients who felt it was difficult to understand the questions, interviewers were asked to explain the meaning item by item until the patients could understand.

Our study assumed that patients had the opportunity to use a new anticancer drug due to their unsatisfactory clinical symptoms. Patients were asked to think carefully among three different new drugs, choosing the one they considered the best and the worst respectively. The duration of the survey ranged from 30 min to 1 hour per patient. All patients were fully informed about the survey and signed informed consent. We gave each patient who participated in the survey a cotton towel worth CNY10 as a gift.

Patient and public involvement
Twenty patients participated in the pilot survey to provide feedback on the acceptability and intelligibility of the questionnaires. Patient responses contributed to a more apprehensible and concise description of the BWDCE questions. The patients participating in the pilot were not involved in the formal survey. No patients took part in the recruitment of study participants or in the conduct of the study.

Statistical analysis
Data from BWDCE can be used to estimate an indirect utility function using random utility theory. Details of the analysis methods are shown in online supplemental appendix 5. The relative importance (RI) of each attribute was calculated based on the difference between the most and least preferred levels within an attribute (the overall utility value of each attribute) divided by the sum of the overall utility values across all attributes. The greater the difference, the more important the change from the most to the least preferred level.

RESULTS
Characteristics of the patients
A total of 495 patients consented to participate in our BWDCE survey. Twenty-seven patients were excluded from the analysis due to non-compliance with the inclusion criteria, incomplete data or a lack of confidence in choosing choice sets. As a result, data from 468 patients were available for analysis. The sample consisted of more females than males (52.99% vs 47.01%) (table 2). The average age was 62.18 years old, ranging from 28 to 93 years old. Patients in our survey had lung cancer (40.17%), breast cancer (34.62%) or colorectal cancer (25.21%). The vast majority of patients (N=401, 85.7%) wanted to actively participate in SDM (4.32±0.77). Most of the patients (N=388, 82.9%) were willing to use the decision aid to obtain evidence on the value of new anticancer drugs (4.25±0.84).

Model estimation of preferences
We found that the most important attribute that determined patients’ preferences for new anticancer drugs was the improvement in health-related quality of life (HRQoL) (RI 36.68%). The low incidence of severe to life-threatening side effects, prolonged progression-free survival (PFS), and the low incidence of mild to moderate side effects were also positive predictors of patients’ preferences (p<0.001) (table 3). The out-of-pocket cost was a negative predictor of their preferences (β=−0.056, p<0.001).

According to the subgroup analysis by type of cancer, HRQoL remained the most important attribute (RI 35.19%–39.23%) (table 4). Furthermore, the significant improvement in HRQoL was the most valued attribute level, regardless of cancer types (p<0.001). Nevertheless, preferences for other attributes varied among different types of patients with cancer. Patients with lung cancer and colorectal cancer rated the incidence of severe to life-threatening side effects as the second most important attribute when choosing a new drug, while patients with breast cancer paid more attention to the length of PFS. Patients with colorectal cancer favoured the new drugs that had a low incidence of mild to moderate side effects (RI 18.15%) compared with other types of cancer (RI 7.48%–12.93%).

Table 2  Characteristics of patients with cancer (N=468)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>220 (47.01)</td>
</tr>
<tr>
<td>Female</td>
<td>248 (52.99)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>255 (54.49)</td>
</tr>
<tr>
<td>65–74</td>
<td>139 (29.70)</td>
</tr>
<tr>
<td>≥75</td>
<td>74 (15.81)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Unschoolled/primary school</td>
<td>187 (39.96)</td>
</tr>
<tr>
<td>Junior high/high school</td>
<td>201 (42.95)</td>
</tr>
<tr>
<td>Junior college or higher vocational college</td>
<td>49 (10.47)</td>
</tr>
<tr>
<td>Bachelor’s degree or above</td>
<td>31 (6.62)</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
</tr>
<tr>
<td>Farmer</td>
<td>152 (32.48)</td>
</tr>
<tr>
<td>Urban employee</td>
<td>138 (29.49)</td>
</tr>
<tr>
<td>Freelancers</td>
<td>42 (8.97)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>7 (1.50)</td>
</tr>
<tr>
<td>Retiree</td>
<td>129 (27.56)</td>
</tr>
<tr>
<td>Monthly household income (CNY)</td>
<td></td>
</tr>
<tr>
<td>≤2000</td>
<td>77 (16.45)</td>
</tr>
<tr>
<td>2001–4000</td>
<td>88 (18.81)</td>
</tr>
<tr>
<td>4001–6000</td>
<td>96 (20.51)</td>
</tr>
<tr>
<td>6001–8000</td>
<td>85 (18.16)</td>
</tr>
<tr>
<td>8001–10000</td>
<td>54 (11.54)</td>
</tr>
<tr>
<td>&gt;10000</td>
<td>68 (14.53)</td>
</tr>
<tr>
<td>Types of cancer</td>
<td></td>
</tr>
<tr>
<td>Lung cancer</td>
<td>188 (40.17)</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>162 (34.62)</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>118 (25.21)</td>
</tr>
<tr>
<td>Duration of cancer diagnosis</td>
<td></td>
</tr>
<tr>
<td>Newly diagnosed*</td>
<td>243 (51.92)</td>
</tr>
<tr>
<td>Previously diagnosed</td>
<td>225 (48.08)</td>
</tr>
</tbody>
</table>

*Patients who received a cancer diagnosis within 3 months at the time of enrolment and the diagnosis of cancer were not attributed to metastatic or recurrent causes (no previous history of cancer).

CNY, Chinese yuan.

Estimation of preference heterogeneity by interaction effects
In terms of interaction effects by age within each type of patient with cancer, no statistically significant interaction term was identified (online supplemental appendix 6). Similarly, we tested the interaction effects using clinical features. Based on the interaction effects of the cancer stages, only the longest PFS in patients with lung cancer had statistical significance (online supplemental appendix 7). Patients with lung cancer who were diagnosed at stage...
III or IV showed stronger preferences for the longest PFS ($\beta=0.547$, p<0.01).

The interaction effects of whether the patients had newly or previously diagnosed cancer cases seemed to be more important than the effects of the cancer stages. We found that previously diagnosed patients with lung cancer paid more attention to the longest PFS ($\beta=0.422$, p<0.05), and might trade the lower incidence of side effects for the prolongation of the PFS. However, newly diagnosed patients with breast cancer placed more emphasis on PFS (p<0.01). Our results also revealed that previously diagnosed patients with colorectal cancer cared more about the significant improvement in HRQoL (p<0.05).

**DISCUSSION**

**Patients’ preferences for new anticancer drugs**

The BWDCE collects more abundant information from a choice scenario than a conventional DCE since it asks not only for the best (most preferred) but also the worst (least preferred) alternative. It has the benefit of obtaining a larger number of observations per respondent. To the best of our knowledge, this is the first BWDCE that involved three common types of patients with cancer and investigated preference heterogeneity within each group. Our findings provide a new understanding of the RI patients attach to different attributes of new anticancer drugs, thus informing the effective implementation of SDM.

We found that the new anticancer drugs patients preferred comprised the following attributes: improving patient-reported health status as reflected by HRQoL; causing few side effects, especially severe to life-threatening events; extending survival and requiring less out-of-pocket costs. Currently, there is a lack of studies comparing the RI of preferences for each attribute among common types of patients with cancer, making it difficult to facilitate SDM due to fragmented preference evidence. Our results revealed both similarities and differences in patients’ preferences by type of cancer. We found that patients considered improvement in HRQoL to be the most important attribute, regardless of cancer type. In addition to the improvement in HRQoL, patients with breast cancer preferred extended PFS, while patients with lung cancer and colorectal cancer were concerned about the incidence of severe to life-threatening side effects. Hence, the preferences of patients with a specific type of cancer may not be applicable to other types of cancer.

Few studies have identified the influence of demographic characteristics and clinical features on patients’ preferences for cancer therapy. Based on our results, age did not significantly affect patients’ preferences for new anticancer drugs. We have a new finding that whether patients were newly diagnosed or previously diagnosed cancer cases had a noticeable influence on their clinical decisions. Patients with previously diagnosed lung cancer showed stronger preferences for the longest PFS. Coincidentally, according to a DCE on patients’ preferences for lung cancer treatment, those who received more than one line of anticancer therapy attached more importance to the longest PFS. Synchronous lung metastasis occurs frequently and is an independent predictor of a poor survival rate. However, newly diagnosed patients with breast cancer placed more emphasis on prolonged PFS. This could be explained by the fact that if breast cancer is diagnosed and treated early, the chance of survival is relatively high, and newly diagnosed patients would express a higher expectation of survival.

Furthermore, we found that previously diagnosed patients with colorectal cancer cared more about improving HRQoL. A study showed that colorectal patients who were 1–3 years after diagnosis would be exposed to a significant HRQoL burden, including urinary incontinence, bowel control problems and sexual matters. Therefore, they may be more concerned with maintaining daily activities and improving HRQoL.

**Implications of the study findings**

Treatment of cancer is often complex, and clinical decisions on new anticancer drugs involve uncertainties, making it well suited for studying SDM. Key SDM goals will be achieved when patients are fully informed...
of treatment options and patient values are incorporated into treatment decisions. Meanwhile, achieving good adherence to medications requires a better understanding of patients’ preferences.33 34

Despite different types of patients with cancer, the attributes of new anticancer drugs involving survival outcome, PROs, safety and affordability were found to affect their clinical decisions. Although the RI of attributes varies among patients with different types of cancer, they are all necessary to implement SDM. For example, the out-of-pocket cost is indispensable when making decisions between drugs where health benefits and safety do not differ significantly. Patients should be aware of the multi-attribute value of new anticancer drugs and be jointly involved in decision-making while honouring their preferences.

SDM is central to evidence-based medicine and high-quality care, but this does not mean that “one-size-fits all”. We observed preference heterogeneity among three common types of patients with cancer. Our BWDCE has a new finding that the improvement of HRQoL is a high priority for each type of patient with cancer. Cancer considerably affects all dimensions of patients’ daily life and makes them vulnerable to deteriorated HRQoL.37 38

The importance of capturing and reporting HRQoL in clinical trials has been increasingly recognised in the field of oncology.39 40 Although improvement in HRQoL played a dominant role in patients’ preferences, there were variations in preferences for other attributes. Differences in the RI of attributes underscore the need for effective communications between clinicians and patients on drug values, which would contribute to more personalised treatment decisions.

With a growing emphasis on the patient-centred care model that incorporates patient values into shared decisions, it is necessary to recognise variations in patients’ preferences and values.41 Patients with previously diagnosed cancer were often excluded from clinical studies, despite limited evidence on their prognosis and preferences. We have a new finding that patients’ preference heterogeneity could mainly be driven by whether they were newly diagnosed or previously diagnosed cancer cases. Therefore, patients’ preferences for new anticancer drugs may change over the course of their disease experience.

Whether patients were newly diagnosed or previously diagnosed cancer cases should be considered as a possible factor affecting patients’ preferences in clinical

### Table 4: Subgroup analysis of patients’ preferences by type of cancer

<table>
<thead>
<tr>
<th>Attributes/levels</th>
<th>Lung cancer</th>
<th>Breast cancer</th>
<th>Colorectal cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef. RI (%)</td>
<td>Coef. RI (%)</td>
<td>Coef. RI (%)</td>
</tr>
<tr>
<td>PFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>-0.596</td>
<td>-1.874†</td>
<td>-0.434†</td>
</tr>
<tr>
<td>12 months</td>
<td>0.219†</td>
<td>0.589</td>
<td>0.100</td>
</tr>
<tr>
<td>24 months</td>
<td>0.377†</td>
<td>1.285†</td>
<td>0.334†</td>
</tr>
<tr>
<td>Change in HRQoL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Even worse</td>
<td>-2.791†</td>
<td>-2.935†</td>
<td>-1.712†</td>
</tr>
<tr>
<td>Slight improvement</td>
<td>1.008†</td>
<td>1.024†</td>
<td>0.572</td>
</tr>
<tr>
<td>Significant improvement</td>
<td>1.783†</td>
<td>1.911†</td>
<td>1.140†</td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td>24.32</td>
<td>18.03</td>
<td>20.90</td>
</tr>
<tr>
<td>60%</td>
<td>-1.790†</td>
<td>-1.582†</td>
<td>-1.108†</td>
</tr>
<tr>
<td>30%</td>
<td>0.744†</td>
<td>0.700†</td>
<td>0.522</td>
</tr>
<tr>
<td>10%</td>
<td>1.046†</td>
<td>0.882†</td>
<td>0.586</td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td>12.93</td>
<td>7.48</td>
<td>18.15</td>
</tr>
<tr>
<td>90%</td>
<td>-0.999†</td>
<td>-0.670†</td>
<td>-0.896†</td>
</tr>
<tr>
<td>60%</td>
<td>0.491†</td>
<td>0.319†</td>
<td>0.320†</td>
</tr>
<tr>
<td>10%</td>
<td>0.508†</td>
<td>0.351†</td>
<td>0.576</td>
</tr>
<tr>
<td>Out-of-pocket costs per months</td>
<td>15.18</td>
<td>15.89</td>
<td>16.29</td>
</tr>
<tr>
<td>Cost (per CNY1000)</td>
<td>-0.059†</td>
<td>-0.072†</td>
<td>-0.044†</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-1422.3154</td>
<td>-1188.7416</td>
<td>-1008.5941</td>
</tr>
<tr>
<td>Participants</td>
<td>188</td>
<td>162</td>
<td>118</td>
</tr>
<tr>
<td>Observations</td>
<td>6768</td>
<td>5832</td>
<td>4248</td>
</tr>
</tbody>
</table>

*p<0.001  †p<0.01

CNY, Chinese yuan; HRQoL, health-related quality of life; PFS, progression-free survival; RI, relative importance.
practice to promote SDM. Patients’ varied preferences for prolonging PFS might be due to their prognostic patterns and expectations for anticancer treatment. The overall unadjusted 5-year follow-up survival proportion was estimated to be 82.6% for breast cancer and 16.3% for lung cancer. On average, the prognosis of lung cancer remains poor, and cases are often diagnosed at later stages. Preferences for the longest PFS among previously diagnosed patients with lung cancer also indicate a substantial need for improved lung cancer diagnostic and treatment approaches. Despite the variations in patients’ preferences, early diagnosis, followed by timely, patient-centred, and appropriate anticancer therapy, is critical to improve health outcomes.

Patients need information that matches their individual needs, and clinicians need support on how to best involve the individual patient in the decision-making process. There is a high demand for SDM but a lack of conclusive evidence on the specific information needs of patients. Our findings also provide evidence on what kind of information patients with common types of cancer would like to receive when it comes to making decisions about new anticancer drug therapies. Communications between patients and clinicians about therapeutics play a crucial role in cancer care by improving patient consent and reducing uncertainty in SDM. Meanwhile, decision aids that provide scientific evidence and help patients evaluate their treatment options deserve to be developed and applied in clinical practice.

**Strengths and limitations**

The major contributions of our study are as follows. First, we performed a BWDCE that followed good research practices, offering the advantages of measuring trade-offs in patient choices and quantifying the strength of preferences. Compared with a standard DCE, the BWDCE can increase the statistical efficiency of the choice models. It becomes a useful tool to provide plentiful sources of preference information. Second, our study, for the first time, compared preferences for new anticancer drugs among three common types of patients with cancer. The findings will enrich the research evidence on preferences of patients with cancer in a systematic and in-depth manner. Third, our study suggests that whether patients are newly diagnosed or previously diagnosed cancer cases has a potential impact on their preferences. The results will facilitate patient-centred decision-making. Fourth, our findings would be helpful for the further development of decision aids that provide evidence to reflect the multiattribute value of new anticancer drugs. Finally, our study highlights the importance of understanding patients’ preferences when implementing SDM, thus improving patient participation in decisions and better aligning anticancer drug therapies with their individual priorities.

Despite the strengths, several limitations of our study should be acknowledged. First, we used a subset of prominent attributes that were identified from the literature review and expert consultation. Due to the methodological requirements of BWDCE, our analysis was unable to include other attributes that could also be meaningful. Second, our study only enrolled three common types of patients with cancer, which might limit the applicability of the findings. Future studies are suggested to enrol patients with other types of cancer. Finally, the BWDCE presents hypothetical choices that may not fully represent the choices respondents have or would make in real-world decision scenarios.

**Conclusion**

In summary, our study suggested that patients with cancer, in general, value several attributes of new anticancer drugs, including HRQoL, toxicity and safety, survival outcomes and affordability. The most influential driver of patients’ preferences was the significant improvement in HRQoL. Patients’ preferences varied according to whether they were newly diagnosed or previously diagnosed cancer cases. During the process of SDM, patients should be informed about the multiattribute values of drugs, empowered to think critically, and encouraged to make decisions reflecting their values.

**Author affiliations**

1Department of Medical Informatics, Nantong University Medical School, Nantong, Jiangsu, China
2Department of Radiotherapy, Tinghu District People’s Hospital, Yancheng, Jiangsu, China
3Department of Medical Informatics, The People’s Hospital of Rugao, Nantong, Jiangsu, China
4Department of Respiratory, Affiliated Hospital of Nantong University, Nantong, Jiangsu, China
5Institute of Special Environmental Medicine, Nantong University, Nantong, Jiangsu, China

**Acknowledgements**

We acknowledge the contributions of our interviewers who conducted one-to-one, face-to-face interviews with the patients. We thank the patients for their efforts and time. When drafting the research protocol, Jinsong Geng was a research fellow at the Fellowship in Health Policy and Insurance Research, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute. We acknowledge the guidance from Professor Hao Yu from Harvard Medical School and Harvard Pilgrim Healthcare Institute on the research methodology.

**Contributors**

JG accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish. JG and GW conducted the study design. JM and TX contributed to the literature search and qualitative analysis. YS, JM, WL and GW contributed to the implementation and quality control of the best–worst discrete choice experiment. ZF and JG performed the statistical analysis and wrote the manuscript.

**Funding**

This work was supported by Science and Technology Project of Nantong City (grant no. MS12021064), MOE (Ministry of Education in China) Project of Humanities and Social Sciences (grant no. 21YJAZH023) and National Natural Science Foundation of China (grant no. 71603138).

**Disclaimer**

The funders provided financial support for the conduct of the study. The funders had no role in the design, implementation, data collection and statistical analysis, data interpretation or writing of the manuscript.

**Competing interests**

None declared.

**Patient and public involvement**

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication**

Not applicable.
Open access

Ethics approval This study involves human participants and this study, including the patient consent process, has been approved by the Medical Ethics Committee of Nantong University (Ethical Approval-2021069) and conforms to the ethical guidelines of the Declaration of Helsinki. Informed, written consent was obtained from all patients prior to their participation in the study. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data will be available on reasonable request to the corresponding author.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iD Jinsong Geng http://orcid.org/0000-0003-3389-9051

REFERENCES


Krumholz HM. Variations in health care, patient preferences, and high-quality decision making. *JAMA* 2013;310:151.


Appendix 1: Literature review of value assessment frameworks for anticancer therapies

Table S1  Domains of value assessment frameworks for anticancer therapies

<table>
<thead>
<tr>
<th>ID</th>
<th>Survival outcomes</th>
<th>Safety/ Tolerability</th>
<th>Economic/ Affordability</th>
<th>Patient- reported outcomes</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badia X 2019¹</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Camps C 2020²</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wagner M 2018³</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Angelis A 2020⁴</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Angelis A 2017⁵</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Thaker NG 2016⁶</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Jiang Q 2020⁷</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Bretoni A 2019⁸</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Doyle JJ 2019⁹</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ezeife DA 2020¹⁰</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Hsu JC 2019¹¹</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Venhorst K 2014¹²</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

“—”: not mentioned in the value assessment framework
Appendix 2: Literature review of attributes and levels regarding anticancer therapies in preference-based studies

Table S2  Attributes and levels of anticancer therapies in preference-based studies

<table>
<thead>
<tr>
<th>Domains</th>
<th>Attributes</th>
<th>Number of literatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival outcomes</td>
<td>Progression-free survival</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Survival (rate/time)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Disease control rate</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Overall survival</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Life expectancy</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Minimum life extension for half of patients compared to current therapy</td>
<td>1</td>
</tr>
<tr>
<td>Safety</td>
<td>Chance/risk of a specific side effect (e.g., diarrhea, nausea, etc.)</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Risk of side effects</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Severity of long-term side effects</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Severity of short-term side effects</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Risk of hospitalization</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Changes in major side effects compared to your current therapy</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Risk of disruption to chemotherapy schedule due to low white blood cell</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>counts (neutropenia)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average increase in toxicity-free days compared to current therapy</td>
<td>1</td>
</tr>
<tr>
<td>Affordability</td>
<td>Costs per month</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Monthly insurance company costs</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total out-of-pocket costs per chemotherapy cycle</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Annual treatment costs per patient</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>Mode /frequency of administration</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Available test to see if the therapy will work</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Drug mechanisms of action</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Waiting time in clinic</td>
<td>1</td>
</tr>
</tbody>
</table>

Only preference-based studies (i.e., discrete choice experiments, best-worst scaling surveys) that aimed to investigate patients’ preferences for the treatment of lung cancer, breast cancer, or colorectal cancer were included in our literature review. A total of 23 studies 13-35 met our inclusion criteria.
Appendix 3: Explanations of the study attributes and levels

Progression-free survival: Progression-free survival (PFS) is the length of time during and after the treatment of cancer that a patient lives with the cancer but it does not get worse. We classify PFS into three levels: 6 months, 12 months, and 24 months. A longer PFS implies a longer period of disease stability.

Change in health-related quality of life: Health-related quality of life (HRQoL) is a multi-dimensional concept that includes domains related to physical (mobility, pain/discomfort), mental (anxiety/depression), social and emotional functioning. We classify the attribute into three levels: even worse, slight improvement, and significant improvement, which reflect the change in HRQoL after receiving new anticancer drugs.

Incidence of severe to life-threatening side effects: Severe to life-threatening side effects refers to grade 3 (severe and undesirable adverse events) or grade 4 (life-threatening adverse events), e.g., severe vomiting, severe diarrhea, severe neutropenia, severe leucopenia, etc. The side effects are significant symptoms requiring medical intervention or hospitalization, complicated by acute, life-threatening complications or consequences. 60% equals a high incidence of side effects, 30% means a moderate incidence of side effects, and 10% indicates a low incidence of side effects.

Incidence of mild to moderate side effects: Mild to moderate side effects means grade 1 (mild) or grade 2 (moderate) adverse events, e.g., mild or moderate hair loss, nausea, asthenia, fatigue, etc. The side effects do not require specific medical intervention or minimal intervention. 90% means a high incidence of side effects, 50% implies a moderate incidence of side effects, and 10% suggests a low incidence of side effects.

Out-of-pocket costs per month: It is the amount of money that a patient should pay out-of-pocket for the new anticancer drug per month.
Appendix 4: Questionnaire used in the survey (Block 1)

Site: __________ Date: _________________ (Year/Month/Day)
Signature of the interviewer: ___________ Block: ___ Number: ________

Informed consent form of the survey

The purpose of this survey is to understand patients’ preferences for new anticancer drugs, and
your information is fully confidential.

Please fill out the informed consent form to indicate your agreement to participate.

Thank you for your cooperation and support!

Signature of the interviewee: ____________

Questionnaire of patients’ preferences for new anticancer drugs

Thank you for taking the time to fill out the questionnaire. The purpose of the survey is to
understand your preferences for new anticancer drugs and to provide evidence for the formulation of
scientific and reasonable healthcare policies.

The results of this questionnaire are only used for academic research. You do not need to worry
about your privacy.

Please answer according to your own feelings and perceptions. After completing the questionnaire,
you will be rewarded with a gift.

If you do not answer carefully, you will provide incorrect information for healthcare decision-
making, thus affecting your own interests.

Thank you again for your kind support!

Evidence-based Medicine Center of Nantong University

1. Personal information

   (1) Gender: O Male O Female
   (2) Age: _____(Years old)
   (3) Education:
       O Unschooledor Primary School O Junior high school O High school
       O Junior college or Higher vocational college O Bachelor’s degree
       O Master’s degree or above
(4) Occupation:
- Civil Servant
- Staffing of public institution
- Company employee
- Factory worker
- Farmer
- Unemployed
- Retiree
- Freelancers (self-employed, temporary stallholder, freelance writer, etc.)
- Other type: ________________

(5) Marital status:
- Single
- Married
- Divorced
- Widowed

(6) Monthly household income (gross income):
- ≤2000 CNY
- 2001~4000 CNY
- 4001~6000 CNY
- 6001~8000 CNY
- 8001~10000 CNY
- 10001~12000 CNY
- >12000 CNY

(7) Type of health insurance:
- Urban Employees Basic Medical Insurance
- Urban-Rural Residents Basic Medical Insurance (including former New Rural Cooperative Medical Insurance, and former Urban Residents Basic Medical Insurance)
- Commercial Health Insurance
- Other types: ________________

(8) The overall satisfaction with your public health insurance:
- Very dissatisfied
- Dissatisfied
- Neither satisfied nor dissatisfied
- Fairly satisfied
- Very satisfied

(9) Do have chronic diseases now (such as diabetes, hypertension, chronic respiratory diseases, especially cardiovascular and cerebrovascular diseases)
- Yes
- No

If yes, name of the disease: ________________________________

Duration of the disease: ______________________ years.

(10) I am willing to actively participate in the clinician-patient shared decision-making of anticancer treatment
- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree

(11) I am willing to know the value of new anticancer drugs with the help of decision-aids that provide scientific evidence
- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree
2. Your preferences for new anti-cancer drugs

Assuming that your clinical symptoms have not been well improved, you need to use a new anticancer drug. Please read all the items carefully and tick ‘✓’ the boxes for the best and worst new drugs.

### Scenario 1

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress free survival (months)</td>
<td><img src="image" alt="6 months" /></td>
<td><img src="image" alt="12 months" /></td>
<td><img src="image" alt="12 months" /></td>
</tr>
<tr>
<td>Health-related Quality of Life</td>
<td>Even worse</td>
<td>Significant improvement</td>
<td>Slight improvement</td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td>30% <img src="image" alt="image" /></td>
<td>30% <img src="image" alt="image" /></td>
<td>60% <img src="image" alt="image" /></td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td>90% <img src="image" alt="image" /></td>
<td>50% <img src="image" alt="image" /></td>
<td>10% <img src="image" alt="image" /></td>
</tr>
<tr>
<td>Out-of-pocket costs per month</td>
<td>2,000 CNY</td>
<td>2,000 CNY</td>
<td>32,000 CNY</td>
</tr>
</tbody>
</table>

Best choice: [ ]

Worst choice: [ ]
### Scenario 2

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress free survival (months)</td>
<td><img src="image" alt="6 months" /></td>
<td><img src="image" alt="24 months" /></td>
<td><img src="image" alt="12 months" /></td>
</tr>
<tr>
<td>Quality of Life</td>
<td><img src="image" alt="Even worse" /></td>
<td><img src="image" alt="Even worse" /></td>
<td><img src="image" alt="Slight improvement" /></td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td><img src="image" alt="30%" /></td>
<td><img src="image" alt="30%" /></td>
<td><img src="image" alt="10%" /></td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td><img src="image" alt="10%" /></td>
<td><img src="image" alt="50%" /></td>
<td><img src="image" alt="90%" /></td>
</tr>
<tr>
<td>Out-of-pocket costs per month</td>
<td><img src="image" alt="32,000CNY" /></td>
<td><img src="image" alt="8,000CNY" /></td>
<td><img src="image" alt="8,000CNY" /></td>
</tr>
</tbody>
</table>

**Best choice**

**Worst choice**
## Scenario 3

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress free survival (months)</td>
<td><img src="image1" alt="12 months" /></td>
<td><img src="image2" alt="24 months" /></td>
<td><img src="image3" alt="12 months" /></td>
</tr>
<tr>
<td>Quality of Life</td>
<td><img src="image4" alt="Slight Improvement" /></td>
<td><img src="image5" alt="Even worse" /></td>
<td><img src="image6" alt="Significant improvement" /></td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td><img src="image7" alt="10%" /></td>
<td><img src="image8" alt="60%" /></td>
<td><img src="image9" alt="30%" /></td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td><img src="image10" alt="50%" /></td>
<td><img src="image11" alt="10%" /></td>
<td><img src="image12" alt="50%" /></td>
</tr>
<tr>
<td>Out-of-pocket costs per month</td>
<td><img src="image13" alt="2,000 CNY" /></td>
<td><img src="image14" alt="32,000 CNY" /></td>
<td><img src="image15" alt="2,000 CNY" /></td>
</tr>
<tr>
<td>Best choice</td>
<td><img src="image16" alt="Best Choice" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worst choice</td>
<td><img src="image17" alt="Worst Choice" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Scenario 4

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Progress free survival (months)</strong></td>
<td><img src="image" alt="24 months" /></td>
<td><img src="image" alt="6 months" /></td>
<td><img src="image" alt="12 months" /></td>
</tr>
<tr>
<td><strong>Quality of Life</strong></td>
<td><img src="image" alt="Slight improvement" /></td>
<td><img src="image" alt="Significant improvement" /></td>
<td><img src="image" alt="Even worse" /></td>
</tr>
<tr>
<td><strong>Incidence of severe to life-threatening side effects</strong></td>
<td><img src="image" alt="30%" /></td>
<td><img src="image" alt="60%" /></td>
<td><img src="image" alt="10%" /></td>
</tr>
<tr>
<td><strong>Incidence of mild to moderate side effects</strong></td>
<td><img src="image" alt="50%" /></td>
<td><img src="image" alt="90%" /></td>
<td><img src="image" alt="50%" /></td>
</tr>
<tr>
<td><strong>Out-of-pocket costs per month</strong></td>
<td><img src="image" alt="16,000 CNY" /></td>
<td><img src="image" alt="16,000 CNY" /></td>
<td><img src="image" alt="8,000 CNY" /></td>
</tr>
<tr>
<td><strong>Best choice</strong></td>
<td><img src="image" alt="Hand-up" /></td>
<td><img src="image" alt="Hand-up" /></td>
<td><img src="image" alt="Hand-up" /></td>
</tr>
<tr>
<td><strong>Worst choice</strong></td>
<td><img src="image" alt="Hand-down" /></td>
<td><img src="image" alt="Hand-down" /></td>
<td><img src="image" alt="Hand-down" /></td>
</tr>
</tbody>
</table>
### Scenario 5

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress free survival (months)</td>
<td><img src="image" alt="24 months" /></td>
<td><img src="image" alt="6 months" /></td>
<td><img src="image" alt="12 months" /></td>
</tr>
<tr>
<td>Quality of Life</td>
<td>Slight improvement</td>
<td>Even worse</td>
<td>Significant improvement</td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td><img src="image" alt="60%" /></td>
<td><img src="image" alt="10%" /></td>
<td><img src="image" alt="30%" /></td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td><img src="image" alt="90%" /></td>
<td><img src="image" alt="50%" /></td>
<td><img src="image" alt="10%" /></td>
</tr>
<tr>
<td>Out-of-pocket costs per month</td>
<td>2,000CNY</td>
<td>8,000CNY</td>
<td>32,000CNY</td>
</tr>
</tbody>
</table>

**Best choice**

**Worst choice**
Scenario 6

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress free survival (months)</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Quality of Life</td>
<td>Significant improvement</td>
<td>Significant improvement</td>
<td>Slight improvement</td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td>60%</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td>10%</td>
<td>10%</td>
<td>90%</td>
</tr>
<tr>
<td>Out-of-pocket costs per month</td>
<td>32,000CNY</td>
<td>32,000CNY</td>
<td>2,000CNY</td>
</tr>
</tbody>
</table>

Please select the score from zero to 10 and give a tick “✓” in the score to reflect your understanding about the choice scenarios and choice sets:

0: extremely difficult
10: extremely easy
Appendix to the questionnaire: Assessment of health-related quality of life

1. Please "√" in the following table according to your actual feeling and health condition

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Slight problems</th>
<th>Moderate problems</th>
<th>Severe problems</th>
<th>Unable to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>② Self-care (e.g. washing, dressing yourself)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>③ Usual activities (e.g. work, study, housework, family or leisure activities)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Severely</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>④ Pain/Discomfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>⑤ Anxiety/Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Mark an X on the scale to indicate how your health

- 100 means the best health you can imagine.
- 0 means the worst health you can imagine.

Please write the number you marked on the scale in the box below.

Your health today = [ ]

Available from: https://euroqol.org/publications/user-guides
3. Patient’s medical history and clinical symptoms (Completed by Interviewers)

Site: ___________  Date: ________________ (Year/Month/Day)

Name of the patient: ___________  Number: ___________

Signature of the interviewer: ___________

Please fill in the following questions after inquiring the information system.

(1) Type of the patient:  ○Outpatient  ○Inpatient

(2) Pathological features of cancer (Classification; Staging; Grading): ________________

(3) Metastases:  ○Yes  ○No

Only for “Metastases-Yes”:  ○Local metastases  ○Distant metastases

(4) Current treatment plan:  □Surgery  □Chemotherapy  □Immunotherapy  □Radiotherapy  □Other ___________

(5) Whether the patient diagnosed as cancer for the first time  ○Yes  ○No

If you choose “No”, please answer Question 6.

(6) How long has it been since cancer was diagnosed ________________ for the first time (The unit of measurement within 1 year is month; The unit of measurement for more than one year is year/month).

Notes: Please do not let patients find this page, in case individual patients are unclear about their own condition.
Appendix 5: Statistical analysis

The random utility theory proposes that the utility for individual $i$ conditional on choice $j$ within the choice set $s$ can be decomposed into an explainable (systematic) part $V_{isj}$ and a random (error) part $\varepsilon_{isj}$:

$$U_{isj} = V_{isj} + \varepsilon_{isj}$$  \hspace{1cm} (1)

According to Equation (1), we put forward the linearly additive indirect utility function as follows:

$$V_{isj} = X'_{isj} \beta_j + Z'_i \gamma$$  \hspace{1cm} (2)

where $X_{isj}$ is the vector of attributes of the choice $j$ as viewed by the individual $i$ in the choice set $s$; $Z_i$ is a vector of characteristics of the individual $i$; $\beta_j$ and $\gamma$ are vectors of coefficients to be estimated.

The characteristics of the respondents are likely to influence their decisions, but they are neither part of the choice alternatives nor a direct source of utility. Mixed logit models can account for respondents’ characteristics by including interaction terms between attributes and the characteristics of individuals. In our study, we extended the main effects model with interaction terms between attribute levels and age, whether they were newly or previously diagnosed cancer cases, as well as cancer stages. The model is as follows:

$$U_{ij} = \beta_0 + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \cdots + \beta_m X_{mij} + \beta_{s1} X_{1ij} S_{interaction term} + \beta_{s2} X_{2ij} S_{interaction term} + \cdots + \beta_{sm} X_{mij} S_{interaction term} + \varepsilon_{ij}$$  \hspace{1cm} (3)

where $\beta_1, \beta_m$ quantifies the strength of preference for each attribute, $\beta_{s1}, \beta_{sm}$ is the parameter weights for interaction terms, and $X_{mij} S_{interaction term}$ represents the interaction terms. The statistically significant effects of the interaction would indicate that patients’ preferences differ by characteristics.

We implemented the above equations using STATA 14.2 SE (STATA Corp LLC, College Station, Texas, USA). We selected the specification with 1500 Halton draws due to the maximum simulated likelihood estimation.
Appendix 6: Interaction effects between attributes and age

Table S3  Interaction effects between attributes and age

<table>
<thead>
<tr>
<th>Interaction terms</th>
<th>Lung cancer</th>
<th>Breast cancer</th>
<th>Colorectal cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
</tr>
<tr>
<td>PFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>-0.276 (0.152)</td>
<td>-0.420 (0.227)</td>
<td>0.089 (0.162)</td>
</tr>
<tr>
<td>24 months</td>
<td>-0.279 (0.186)</td>
<td>-0.565 (0.311)</td>
<td>-0.083 (0.187)</td>
</tr>
<tr>
<td>Change in HRQoL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly improvement</td>
<td>-0.312 (0.167)</td>
<td>-0.053 (0.230)</td>
<td>0.192 (0.155)</td>
</tr>
<tr>
<td>Significant improvement</td>
<td>-0.134 (0.236)</td>
<td>0.153 (0.363)</td>
<td>0.208 (0.220)</td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>-0.080 (0.156)</td>
<td>-0.046 (0.212)</td>
<td>0.198 (0.157)</td>
</tr>
<tr>
<td>10%</td>
<td>0.008 (0.180)</td>
<td>-0.419 (0.216)</td>
<td>0.072 (0.170)</td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td>0.050 (0.189)</td>
<td>-0.154 (0.278)</td>
<td>-0.125 (0.193)</td>
</tr>
<tr>
<td>10%</td>
<td>0.181 (0.185)</td>
<td>-0.594 (0.306)</td>
<td>-0.108 (0.211)</td>
</tr>
<tr>
<td>Out-of-pocket costs per months</td>
<td>-0.005 (0.009)</td>
<td>-0.034 (0.019)</td>
<td>-0.013 (0.011)</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-1412.591</td>
<td>-1176.3726</td>
<td>-1004.3975</td>
</tr>
<tr>
<td>Participants</td>
<td>188</td>
<td>162</td>
<td>118</td>
</tr>
<tr>
<td>Observations</td>
<td>6768</td>
<td>5832</td>
<td>4248</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05; SE, standard error; PFS, progression-free survival; HRQoL, health-related quality of life; Age: Young or middle-aged (aged 64 or younger, reference case) = 0, Elderly (aged 65 or older) =1.
## Appendix 7: Interaction effects between attributes and clinical features

### Table S4  Interaction effects between attributes and clinical features

<table>
<thead>
<tr>
<th>Interaction terms</th>
<th>Lung cancer</th>
<th>Breast cancer</th>
<th>Colorectal cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1 Mean (SE)</td>
<td>Model 2 Mean (SE)</td>
<td>Model 1 Mean (SE)</td>
</tr>
<tr>
<td>PFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>-0.175 (0.151)</td>
<td>0.007 (0.160)</td>
<td>-0.336 (0.293)</td>
</tr>
<tr>
<td>24 months</td>
<td>0.547** (0.187)</td>
<td>0.422* (0.200)</td>
<td>-0.651 (0.388)</td>
</tr>
<tr>
<td>Change in HRQoL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly</td>
<td>0.167 (0.155)</td>
<td>0.206 (0.159)</td>
<td>-0.149 (0.304)</td>
</tr>
<tr>
<td>improvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td>0.154 (0.219)</td>
<td>0.245 (0.228)</td>
<td>0.124 (0.470)</td>
</tr>
<tr>
<td>improvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence of severe to life-threatening side effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>-0.074 (0.151)</td>
<td>-0.340* (0.160)</td>
<td>-0.400 (0.258)</td>
</tr>
<tr>
<td>10%</td>
<td>0.032 (0.180)</td>
<td>-0.193 (0.191)</td>
<td>-0.215 (0.302)</td>
</tr>
<tr>
<td>Incidence of mild to moderate side effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td>-0.141 (0.196)</td>
<td>-0.651** (0.213)</td>
<td>-0.191 (0.378)</td>
</tr>
<tr>
<td>10%</td>
<td>-0.232 (0.189)</td>
<td>-0.421* (0.210)</td>
<td>-0.732 (0.377)</td>
</tr>
<tr>
<td>Out-of-pocket costs per months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>-0.006 (0.009)</td>
<td>-0.006 (0.009)</td>
<td>0.020 (0.017)</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-1410.418</td>
<td>-1409.323</td>
<td>-1178.432</td>
</tr>
<tr>
<td>Participants</td>
<td>188</td>
<td>162</td>
<td>118</td>
</tr>
<tr>
<td>Observations</td>
<td>6768</td>
<td>5832</td>
<td>4248</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05; SE, standard error; PFS, progression-free survival; HRQoL, health-related quality of life.

Model 1: Interaction effects between attributes and stages of cancer. Stages of cancer: stage I and II = 0, stage III and IV =1;
Model 2: Interaction effects between attributes and whether patients were newly or previously diagnosed cancer cases. Newly diagnosed cancer patients (reference case) = 0, Previously diagnosed cancer patients = 1.
References


