Comparing the Monetary Value of a Quality-Adjusted Life Year from the Payment Card and the Open-ended Format

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Abstract

Background: The payment card (PC) format and the open-ended (OE) format are common methods in eliciting willing-to-pay (WTP) of one additional quality-adjusted life year (QALY). The aim of this research is to compare these two formats in eliciting the monetary value of a QALY.

Methods: A contingent valuation survey was carried out using a pre-designed questionnaire with various hypothetical scenarios. The difference between the PC and the OE formats was evaluated by a two-sample equality test. Furthermore, regression analysis was carried out to control observed heterogeneity and to test theoretical validity.

Results: In total, 461 individuals were involved, among whom 235 (51%) answered the PC question, while 226 (49%) answered the OE question. Excluding zero response and 1% top values, the mean WTP values of these two formats vary dramatically, which is 93,424 RMB (SD 117,601) for the PC, 143,347 RMB (SD 209,821) for the OE. Subgroup analysis indicated that the OE format tended to elicit lower values for less serious condition and higher values for more serious condition. Both formats were proved to be theoretically valid, whereas the OE technique was found to have a stronger association with most variables in the regression model than that of the PC format. Moreover, joint estimation indicated a significantly positive effect on the OE results.

Conclusions: This research indicated that the PC format and OE format elicited different monetary value of a QALY, but both formats were proved to be theoretically valid. More research about the difference and the validity of various WTP eliciting methods would be recommendedfor a robust estimation of WTP/QALY.

1. Background

Budget allocation is one of the most prominent matters for decision makers in health-care systems today. The allocation is a complex, multifaceted issue. One of the vital questions, related to the budget allocation, is how much health-care systems should spend on the improvement of health-related outcome in terms of one additional quality-adjusted life year (QALY). Common decision rules of economic evaluations indicate that an intervention is believed to be cost-effective if the incremental cost-effectiveness ratio (ICER) of cost-effectiveness analysis (CEA) falls below the cost-effectiveness threshold value. Generally, there are two main approaches to this value, each taking a perspective from the demand side or supply side of the market [1, 2]. Those supply-side thresholds represent the health opportunity cost, indicating that whether a medicine is worthy of its cost depends on whether the amount of health-related outcomes it produces is larger than the health outcomes that could have been generated if some other medicine got funded [3]. Nevertheless, demand-side methods are in line with the method taken in other public sectors as well as a welfarist approach, where the monetary value of one additional QALY is estimated as willing-to-pay per QALY (WTP/Q) by contingent valuation (CV) surveys . It is

believed that WTP/Q can help improve efficiency in the margin within the healthcare sector as well as between sectors [4].

CV is usually used to elicit monetary values of a non-market good or service [5] by requesting participants to state their willingness-to-pay (WTP) for obtaining a good, in this context, for QALY (always a small amount). In the last decade, there are numerous studies estimating WTP per QALY (WTP/Q) [6-13]. Typically, individuals have been asked about their WTP for health gains for which utility values were measured by EQ-5D population tariffs, Time-Trade-Off, Standard Gamble or Visual Analogue Scale.

However, great disparities exist in the type of health gain, respondents' characteristics, and survey methodology—all of which may influence the perceived estimates of WTP/Q. Ryen et al. (2014) [14] included 24 studies and indicated that the WTP/Q value is significantly higher if the QALY gain comes from life extension rather than quality of life improvements. By comparing 2 similar surveys, Bobinac and colleagues [8] stated that WTP/Q is higher when the health gain in the survey scenario is uncertain. However, the impact of different CV questionnaire format has been barely investigated.

CV questionnaire format denotes the approach by which the respondent is required to provide their WTP, of which four classical techniques have been in use: iterative bidding, dichotomous choice, open-ended (OE) and payment card (PC) [15]. In this research, we focus on the latter two techniques, the OE and the PC format.

The PC technique was proposed by Mitchell [16] and first used in the general economics literature by Jones-Lee et. al [17]. Respondents were given a specific range of monetary values and asked to select the maximum value they would be willing to pay for a particular benefit. On account of the good performance of imitating real life by letting respondents ponder their WTP, the PC has become a prevalent method of eliciting WTP in health economics. The OE elicitation technique directly asks the respondent the maximum they would be willing to pay in a hypothetical scenario. As respondents are prone to anchoring on proposed values when the elicitation technique suggests the values, the OE method can lead to a more precise and independent WTP value than other elicitation techniques, as it does not suggest an answer [18]. It was further verified that the OE format is an effective technique if the final decision depends on a quantile instead of the mean [19].

There are several reasons why the PC and the OE method are chosen for this research. First of all, these two methods have been used broadly in estimating WTP per QALY [7-10]. Moreover, the advantages of using the PC and the OE method were that they were easier to understand and they required a short time for interviews, which is really important considering the respondent burden is a major concern due to the complexity of hypothetical scenario in estimating WTP/Q.

Given the popularity of the PC and the OE in health economics, more specifically, in estimating the monetary value of QALY, a plausible development is a direct comparison of these two formats. Although there is no research comparing these two methods in estimating WTP/QALY, studies have examined the discrepancies of eliciting methods in other fields. A general finding is that for health-related goods, the OE

format causes lower WTP values [20, 21]. However, for environmental goods [22] or an ambulance helicopter service [23], relatively equal values were reported.

The aim of this research is straightforward, taking focus on the comparison of the PC and the OE formats. First, we examined the difference of WTP/QALY estimates from these two methods. Furthermore, we investigated the theoretical validity of each method to determine which method elicits more valid monetary value of QALY.

2. Methods

2.1. Study design and sample

We conducted a CV survey on general Chinese population between June 1st, 2019 and August 10th, 2019. A relatively low response rate was observed in the pilot study of the probability sample survey. Hence, quota sampling was used in the final survey with quotas based on sex, age, and income. First, study participants were recruited in-person by trained interviewers, then we interviewed those who satisfied the quotas. A questionnaire that measures maximum WTP per QALY for various hypothetical scenarios was used in this research. This survey was carried out with trained interviewers through telephone (a mobile app "WeChat"). Five different health statuses were defined using five-level EuroQol five-dimensional questionnaire (EQ-5D-5L) descriptions [24, 25], including three treatment settings and two end-of-life scenarios. More details will be discussed in the next section. All subjects were asked for their full consent to participate in the study and no financial incentives were offered.

2.2. Questionnaire

The full questionnaire contained 22 questions concerning quality of life, WTP, and demographic items as well as health-related issues. The demographic section included questions about age, sex, marital status, education, and family income. First, we evaluated the individuals' present health state using the EQ-5D-5L. Part 2 consisted of a hypothetical health state and a WTP exercise in which we asked individuals to state the maximum amount he or she would be willing to pay for treatment of a hypothetical condition. An example of part 2 can be found in the Additional file 1 [see Additional file 1]. To avert possible extreme WTP values and reveal general treatment in each scenario, small QALY gains, 0.2 QALY and 0.4 QALY, were applied in this research. Altogether, 10 eliciting scenarios were constructed (see Table 1).

Table 1 Scenarios of questionnaire

	Health state	No		EQ-5D-5L description	QALY gain	Period (months)†
Treatment scenario	Mild	1	12122	I have no problems in walking about; I have slight problems washing or dressing myself; I have no problems doing my usual activities; I have slight pain or discomfort; I am slightly anxious or depressed	0.2	15
	Mild	2			0.4	31
	Moderate	3	23332	I have slight problems in walking about; I have moderate problems washing or dressing myself; I have moderate problems doing my usual activities; I have moderate pain or discomfort; I am slightly anxious or depressed	0.2	5
	Moderate	4			0.4	10
	Severe	5	44332	I have severe problems in walking about; I have severe problems washing or dressing myself; I have moderate problems doing my usual activities; I have moderate pain or discomfort; I am slightly anxious or depressed	0.2	3
	Severe	6			0.4	6
Terminal illness		7			0.2	15
		8			0.4	26
Immediate death		9	11115	I have no problems in walking about; I have no problems washing or dressing myself; I have no problems doing my usual activities; I have no pain or discomfort; I am extremely anxious or depressed	0.2	3
		10			0.4	6

† Since QALY=the period of life length (year) * utility of health state, the period was calculated as follows:

For treatment scenarios, the period (month)=QALY gain/(utility of health state after treatment - utility of health state before treatment)*12,

Health state after treatment is perfect health, hence, the period (month) = QALY gain/ (1- utility of health state before treatment) * 12

For terminal illness and immediate death, the treatment can prolong life expectancy in assumed health state, which should result in 0.2 or 0.4 QALY gain. Hence, for terminal illness the period (month) = QALY gain/utility of health state*12+3. For immediate death, QALY gain/utility of health state*12

For treatment scenarios, a hypothetical scenario with description of EQ-5D-5L (the health states mentioned in Table 1) was explained to participants. Without any treatment, they would live with the described health state for XX months. After XX months, they would fully recover. For each hypothetical health state, the WTP value was measured by the respondents' willingness to purchase the treatment.

We also specified the following conditions to each respondent to clarify the assumed situation; (a) the treatment was not reimbursed by public health insurance, the full amount had to be paid beforehand; (b) loss of income due to the illness need not be considered (it is compensated by social security.); and (c) payment for the treatment will influence the respondents' household.

"Terminal illness scenario" reflected the assumption that participants suffered a terminal disease with 3 months in severe health state (EQ-5D-5L description: 44332). A newly developed treatment could prolong life expectancy by 12 months (0.2 QALY) or 24 months (0.4 QALY) in that severe health state. For

"immediate death scenario", we assumed that because of fatal sickness, the respondents would die immediately. However, in this scenario we hypothesized that there was a treatment that could prolong life expectancy by 3 months (0.2 QALY) or 6 months (0.4 QALY) in health state 11115[1].

The WTP payment was defined as the amount of out-of-pocket expense to purchase an assumed intervention. Participants were asked if he or she would pay for the treatment. Those who replied "No" were then asked to give their reasons. If the answer was "yes", the participant was requested to provide the maximum amount they were willing to pay out of pocket. The PC had the following categories: 3200 RMB (5 percent of Chinese GDP per capita, USD 457), 6450 RMB (10 percent of Chinese GDP per capita, USD 922), 12,900 RMB (20 percent of Chinese GDP per capita, USD 1,844), 25,800 RMB (40 percent of Chinese GDP per capita, USD 3,688), 51,600 RMB (80 percent of Chinese GDP per capita, USD 7,376), 77,400 RMB (120 percent of Chinese GDP per capita, USD 11,064), 103,200 RMB (160 percent of Chinese GDP per capita, USD 14,753).

2.3. Data analysis

Previous studies have applied two different methods of converting the data on WTP and QALY gains into WTP per QALY estimates, namely aggregated method and disaggregated method. The aggregated approach calculates the ratio by dividing the mean of WTP by the mean of QALY, whereas the disaggregated method estimates WTP/QALY for individuals, and subsequently estimates the mean value of WTP/QALY, which was proved to be a more appropriate method as it takes account of heterogeneity in preferences as well as individual's marginal rate of substitution between health and money [26, 27]. Hence, the disaggregated method was applied in this research.

Descriptive statistics (mean, SD, median, inter-quartile range, minimum, maximum) for the WTP values of the PC and the OE formats were computed. Zero response of each format were compared and excluded for further analysis. In order to reduce the impact of outliers, the top 1% of values in both the OE and PC formats were trimmed for additional comparison. First, we compared the mean and the median WTP/QALY obtained from the two elicitation methods using a two-sample equality test with bootstrapping. Additionally, a subgroup analysis of diverse scenarios was conducted.

Linear multiple regression and log-linear multiple regression were carried out to control observed heterogeneity and test theoretical validity. In a broad sense, the theoretical validity of WTP/QALY estimates refers to whether the estimates concur with the underlying theory. The subsequent variables[2] were selected for regression analysis in conformity with previous researches [11-13]: age, income, hypothetical health state, and QALY gain. Age was proven to be a significant factor of WTP/QALY in previous research [11], indicating that being younger led to a higher WTP/QALY. Income is positively associated with WTP/QALY [12] and thus should be captured in the regression analysis. Furthermore, we also assumed that worse health state scenario [13] and smaller QALY gain should lead to a higher WTP/QALY [9]. Categorical variables were coded with dummy variables. Statistical analysis was performed with IBM SPSS version 23.0.

Footnotes:

[1] We used perfect health (11111) in the pilot study, which was believed to be to ideal since most people feel extreme anxious in face of death. Hence, 11115 (5 means extreme anxious or depressed) was used for the immediate death scenario.

[2] The regressors were chosen based on the bivariate analysis (the Mann-Whitney U-tests for dichotomous variables, Kruskal-Wallis H tests for polychromous variables, Spearman's rank correlation coefficient for the continuous variable) as well as previous researches

3. Results

3.1. Respondent characteristics and summary statistics

Table 2 displays the demographic characteristics of respondents. In total, 461 individuals were involved, among whom 235 (51%) answered the PC question, while 226 (49%) answered the OE question. 61% of participants had a college degree. Around 35% of respondents had income less than 3000 RMB. Almost 19% participants in this research proclaimed that they were having some health problems. However, for all the dimensions in EQ-5D-5L, most respondents reported no problem. The mean utility score of respondents was 0.95.

A small portion of respondents (5%) had experienced hospitalization during the year. We found no significant differences between elicitation methods for all variables except education (p=0.001). The sample size of each QALY gain and scenario can be found at table 3, which was quite similar for the PC group and the OE group.

Table 2 Respondents' characteristics (N = 461)

Characteristic	Full sample Mean ± SD or N (%)	PC Mean ± SD or N (%)	OE Mean ± SD or N (%)
n	461 (100%)	235 (51%)	226 (49%)
Age	32.86 ±11.84	31.92 ±11.27	33.84±12.36
Gender			
Male	219 (48%)	110 (47%)	109 (48%)
Female	242 (52%)	157 (53%)	117 (52%)
Education*			
≤Primary school	29 (6%)	11 (5%)	18 (8%)
Secondary school	76 (17%)	25 (11%)	51 (23%)
High school	76 (17%)	39 (17%)	37 (16%)
≥College	280 (61%)	160 (67%)	120 (53%)
Marital status			
Single	223 (48%)	105 (45%)	118 (52%)
Married	235 (51%)	130 (56%)	105 (47%)
Divorced/separated	2 (0%)	0 (0%)	2 (1%)
Widowed	1 (0%)	0 (0%)	1 (0%)
Income			
≤3000	162 (35%)	83 (35%)	79 (35%)
3001-5000	173 (38%)	85 (36%)	88 (39%)
>5000	126 (27%)	67 (29%)	59 (26%)
Health utility	0.95 ± 0.07	0.95 ± 0.06	0.94 ± 0.09
Hospitalization experience during the year			
Yes	20 (5%)	7 (3%)	14 (6%)
No	441 (95%)	228 (97%)	213 (94%)
Health problems			
Yes	86 (19%)	44 (19%)	42 (19%)
No	375 (81%)	191 (81%)	184 (81%)

* indicates there is significant difference between PC group and OE group on education

Table 3 Sample size of each QALY gain and scenario

	Full sample	PC	OE
QALY			
0.2	222 (48%)	113 (48%)	109 (48%)
0.4	239 (52%)	122 (52%)	117 (52%)
Scenario			
Mild	101 (22%)	51 (22%)	50 (22%)
Moderate	87 (19%)	44 (19%)	43 (19%)
Severe	84 (18%)	45 (19%)	39 (17%)
Terminal illness	94 (20%)	51 (22%)	43 (19%)
Immediate death	95 (21%)	44 (19%)	51 (23%)

3.2. Comparing formats with unconditional analysis

The distribution of WTP/Q of the PC and the OE formats is displayed in Fig. 1. Furthermore, Table 4 presents descriptive statistics of WTP/QALY for the two elicitation methods. This research showed a small number of zero response, which is 28 (12%) for the PC, 36 (16%) for the OE with no significant difference of these two groups. Nevertheless, excluding zero response and 1% top values, the mean WTP values of these two formats vary dramatically, which is 93,424 RMB (SD 117,601) for the PC, 143,347 RMB (SD 209,821) for the OE. However, the median values of the PC and the OE are quite similar, which is 32,250 RMB for the PC and 50,000 RMB for the OE. We examined equality among mean and median WTP/QALY. Results reported in the Table 4 indicate that the mean WTP/QALY of the OE method was significantly higher than that of the PC format. However, no substantial difference was found between the median of these two methods. Fig. 2 displays the ratio of accepted bids according to the elicitation method. These two crossing lines indicated that the OE format tended to elicit more extreme values, though the difference between two elicitation methods did not seem to be substantial.

Table 4 Descriptive statistics and equality tests of WTP per QALY using PC and OE formats

	All sample	PC	OE	P value
Zero response, N (%)	64 (14%)	28 (12%)	36 (16%)	0.227
Mean	117,305	93,424	143,347	0.008**
Standard deviation	169,772	117,601	209,821	--
Median	50,000	32,250	50,000	0.618
Maximum	1,000,000	516,000	1,000,000	--
Minimum	500	8,000	500	--

PC payment card, *OE* open-ended

The results of subgroup analysis are presented in Table 5, which are, to some degree, inconsistent with the whole sample analysis. For mild health state scenario, the PC yielded higher mean value, whereas for all other four health scenarios, the OE method was witnessed with much bigger mean WTP/QALY valued. However, equality test showed significant difference of the means only for immediate death scenario. Noteworthy differences were found in the median for these two formats in three of five scenarios. For moderate treatment scenario, terminal illness scenario and immediate death scenario, the OE method elicited significantly higher median values.

Table 5 Comparison between the PC and the OE formats by different scenarios

Scenarios		Mean ± SD	Mean Difference	95% Interval of mean difference by bootstrap	Equality test of mean (bootstrap)	Median	Equality test of median
Mild	PC	30711±25979	8913	(-2074, 19340)	0.102	24188	0.989
	OE	21798±23978				15000	
Moderate	PC	64089±85563	-19728	(-58644, 18033)	0.303	48375	0.001**
	OE	83818±79926				75000	
Severe	PC	26059±17952	-3316	(-15771, 6950)	0.567	16125	0.995
	OE	29375±20602				225000	
Terminal illness	PC	220983±128185	-76517	(-176993, 16449)	0.138	225750	0.05*
	OE	297500±259447				250000	
Immediate death	PC	129473±128608	-171868	(-274233, -69502)	0.001**	64500	0.04*
	OE	301341±267232				250000	

PC payment card, *OE* open-ended, *SD* Standard deviation,

*indicates there is significant difference between PC group and OE group (p<0.05); **indicates there is significant difference between PC group and OE group (p<0.01)

3.3. Comparing formats with conditional analysis

3.3.1. Separate estimations by elicitation format

For each elicitation method we looked for the determinants of WTP/QALY with linear multiple regression models and log-linear multiple regression models (Table 6). In the OE format, all variables were found to have significant effect on the value of WTP/QALY. More specifically, for the OE technique, participants' age was verified to be negatively relevant to their WTP: as respondents' age increase, their WTP decreased, which was consistent with the research assumption. However, in case of the PC question, age was not a statistically significant variable. WTP/QALY was also proved to be significantly influenced by valuation scenarios in both models, while participants were prepared to pay more for more serious conditions. We found a positive effect of income on WTP/QALY for both formats—which argues for the validity of the stated-preference survey [24], even though the difference of WTP/QALY values for income group 3001-5000 RMB and base-case group (income less than 3000 RMB) was not significant. Furthermore, we confirmed that for both formats, smaller QALY gain led to a higher WTP/QALY.

3.3.2. Joint estimation over the two elicitation formats

We studied the impact of the elicitation technique on WTP over the whole sample by introducing dummy variables for the OE format (the PC format as the reference). The linear regression with whole sample indicated statistically significant positive effect on the OE results, consequently verifying the results of

the conditional analyses. However, log-linear regression found no significant different of these two formats. Regarding the determinants of WTP, the joint estimation confirms previous results: a significant and negative effect of age and QALY gain, a significant and positive effect of income. WTP/QALY was also proved to be affected by valuation scenarios.

Table 6 Linear regression for positive WTP values (natural logarithms)

	PC, n=205				OE, n=188				All, n=393			
	Linear regression		Log-linear regression		Linear regression		Log-linear regression		Linear regression		Log-linear regression	
	B	P	B	P	B	P	B	P	B	P	B	P
Constant	166684	0.00**	11.47	0.00**	380585	0.00**	12.5	0.00**	246455	0.00**	11.92	0.00**
OE (vs. PC)	-	-	-	-	-	-			56150	0.00**	0.1	0.30
Age	-1085	0.06	-0.01	0.16	-2566	0.02*	-0.02	0.04*	-1711	0.00**	-0.01	0.03*
Scenario (vs. Immediate death)												
Mild	-100870	0.00**	-1.10	0.00**	-287956	0.00**	-2.53	0.00**	-197549	0.00**	-1.82	0.00**
Moderate	-73224	0.00**	-0.65	0.00**	-237108	0.00**	-1.42	0.00**	-160298	0.00**	-1.08	0.00**
Severe	-104465	0.00**	-1.25	0.00**	-259869	0.00**	-2.15	0.00**	-190015	0.00**	-1.75	0.00**
Terminal illness	94946	0.00**	0.95	0.00**	2761	0.00**	0.41	0.12	39441	0.06	0.61	0.00**
Income (vs. ≤3000)												
3001-5000	5153	0.72	0.10	0.46	58938	0.03*	0.42	0.03*	32004	0.04*	0.26	0.03*
>5000	59332	0.00**	0.58	0.00**	121960	0.00**	0.8	0.00**	92707	0.00**	0.71	0.00*
QALY gain (vs. 0.2 QALY)												
0.4 QALY	-39208	0.00**	-0.48	0.00**	-83749	0.00**	-0.69	0.00**	-60515	0.00**	-0.58	0.03*
Adjust R²	0.47		0.54		0.45		0.56		0.43		0.53	

PC payment card, *OE* open-ended, *S.E.,* standard error, *QALY* quality-adjusted life year

[*] indicates that there are statistically significant differences at the 5% level; [**] indicates that there are statistically significant differences at the 1% level

4. Discussion

We compared WTP/QALY estimates generated from the PC format and the OE format and found that the mean WTP values of these two formats vary dramatically. However, the median values of the PC and the OE are quite similar. Subgroup analysis showed that for mild health state scenario, the PC yielded higher mean value, whereas for all other four health scenarios, the OE method was witnessed with much bigger mean WTP/QALY value. Further investigation with conditional analysis demonstrated statistically significant positive effect on the OE results and proved the validity of both.

As we have shown in the results, there was significant difference with the overall mean WTP/QALY estimates for each format. One may argue that since different health state yields different WTP/QALY value, looking at aggregate outcomes may ignore the real difference between these two techniques. Hence, we further compared these two formats for different subgroups. It was found that the OE format was related with much bigger average value and median for most scenarios except mild health state scenario. Nevertheless, due to the great variation of the data set, the equality test of mean with bootstrapping found no significant difference with these two formats except in immediate death scenario. However, the equality test of median indicted that the OE method elicited statistically significantly higher median values for moderate treatment scenario, terminal illness scenario and immediate death scenario. The fact that the median is much more robust to outliers than the mean values might explain these inconsistent equality test results.

Our finding is that these two methods seem to lead to different estimates, which is differs also from previous research in healthcare. By asking questions of women's WTP for a screen process, Donaldson et.al [20] concluded that the PC format was related with higher mean and median WTP, which was proved again by the study on colorectal cancer screening of Whynes and colleagues [21]. The possible explanation for this inconsistency is that the OE format tended to elicit lower values for less serious condition and higher values for more serious condition. We may argue here that body screening as well as mild treatment scenario in this research could be considered as less serious condition, where the OE format tended to elicit lower values.

The theoretical validity can be examined by determining whether the results are consistent with theoretical constructs. Probing the theoretical validity is the most popular test of validity applied to stated-preference techniques mostly since it is comparatively easy to perform. The performance of the OE format appears to be highly satisfactory, whereas the PC format failed to comply with the assumption that being younger leads to a higher WTP/QALY, it was consistent with all other assumptions, which indicated acceptable theoretical validity. In comparison with the PC format, the OE technique had a stronger association with most variables in the regression model. In theory, the PC question tends to cause range bias. In the OE form, only after a careful reflection can respondents answer WTP question [18], which might be a fundamental procedure in assessing the value of health.

This is the first study to compare WTP/QALY estimates generated from the PC and the OE formats. However, we have encountered certain practical limitations. First, only the theoretical validity of the two eliciting methods was performed; essential elements like external validity and reliability were not assessed in this study. Second, quota sampling instead of probability sampling was applied in this research. Hence, the participants used in this study may not be a perfect representation of the Chinese population. Due to the cognitive challenge of this type survey, most studies of WTP include a sample with a higher education compared to the general population [28, 29]. In this study, those with higher levels of education were over-represented. However, we found that education level had no significant impact on WTP/QALY. Hence, the potential bias in the WTP estimate is likely to be minor. Third, according to previous research [4], respondents' health state, especially those who had health state worse than the

hypothetical questions, might influence their WTP for a QALY, but we did not perform any analysis regarding to this issue since most participants stated perfect health. There were 5 participants whose health state is worse than the illness state in the hypothetical questions, all came from mild treatment scenario (two for PC group and three for OE group). One refused to pay anything for the treatment, the other four state plausible payment. Moreover, we did not distinguish genuine zeros from protest responses, and zero responses were excluded in the data analysis, which might potentially bias our conclusion. Finally, a critical limitation is the imaginary nature of all WTP surveys [30]. Like other studies, the participants might find it hard to picture a hypothetical health state that significantly differs from conditions that they have experienced before. More research about the validity of various WTP eliciting methods would be needed for a robust estimation of monetary value per QALY.

5. Conclusions

The study compared WTP/QALY estimates generated from the PC and the OE formats and found that the mean WTP values of these two formats vary dramatically. However, the median values of the PC and the OE are quite similar. Subgroup analysis indicated that the OE format tended to elicit lower values for less serious condition and higher values for more serious condition. Further investigation with conditional analysis demonstrated statistically significant positive effect on the OE results and proved the validity of both methods. More research about the validity of various WTP eliciting methods would be needed for a robust estimation of WTP/QALY.

6. Abbreviations

PC: payment card

OE: open-ended

WTP: willing-to-pay

QALY: quality-adjusted life year

ICER: incremental cost-effectiveness ratio

CEA: cost-effectiveness analysis

CV: contingent valuation

EQ-5D-5L: five-level EuroQol five-dimensional questionnaire

7. Declarations

Ethics approval and consent to participate

According to *Ethical review methods for human biomedical research issued* by Ministry of Health in China, scientific research department of Shenyang Pharmaceutical University, who is responsible for the ethics review, ruled that no formal ethics approval was required in this case. Considering the survey was carried out via telephone, written consent was not available. Instead, verbal informed consent was obtained from the respondents for the publication of this report

Consent for publication

Not applicable.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Competing interests

The author declares that he has no competing interests.

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Authors' contributions

ZY and LS conceived the original concept of the study, applied for the grant and assisted in study protocol development and implementation. ZY, FL, JM, ZZ and CW conducted this survey and wrote the manuscript. All authors contributed to the final design of the study protocol and have read and approved the final manuscript.

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Figures
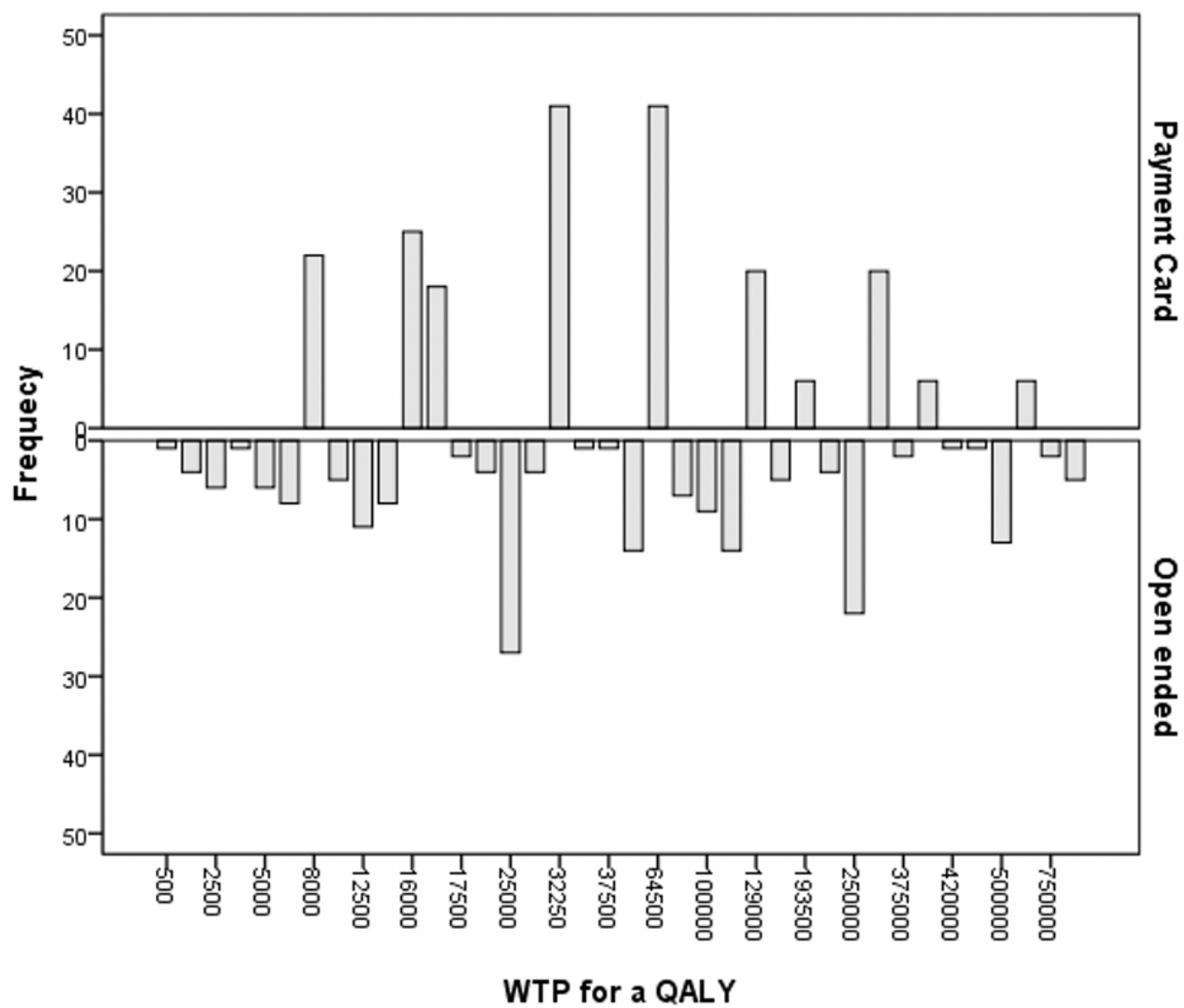
Figure 1

The distribution of willingness-to-pay per QALY of the PC and the OE formats
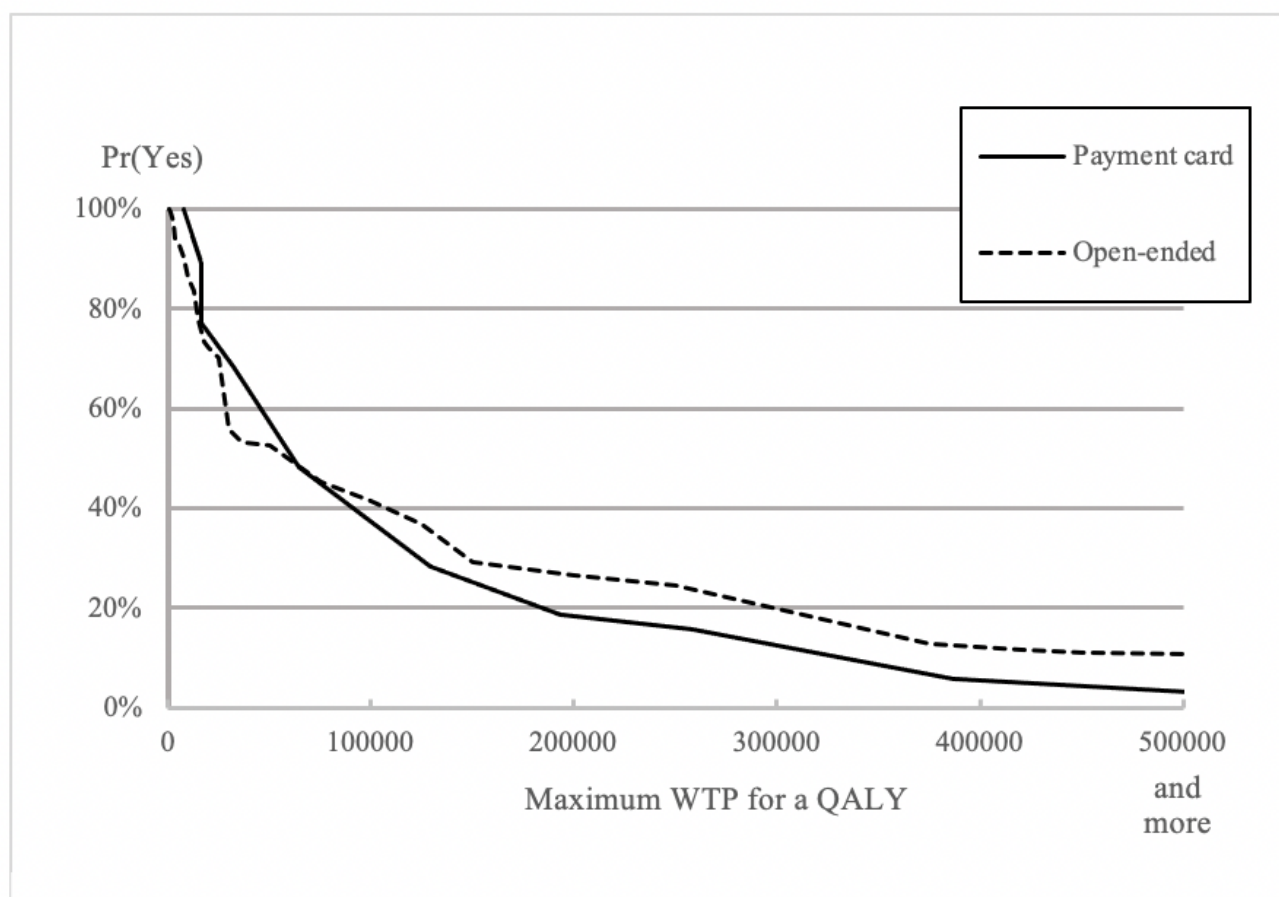
Figure 2

Proportion of accepted bids by elicitation format