

*Work in Progress*

## **Discrete choice experiment with a Contingent Valuation follow-up question**

Marjon van der Pol<sup>1</sup>, Alan Shiell<sup>2,3</sup>, Flora Au<sup>2</sup>, Suzanne Tough<sup>2,4</sup>; David Jonhston<sup>4</sup>

<sup>1</sup>University of Aberdeen; <sup>2</sup>University of Calgary; <sup>3</sup>Monash University; <sup>4</sup>Calgary Health Region

**Author for correspondence:** Marjon van der Pol, Health Economics Research Unit, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD. Email: m.vanderpol@abdn.ac.uk

## **Abstract**

Evidence suggests that different methods of eliciting monetary values that individuals ascribe to health (services) produce different results. As a result, doubts have been raised over the use of monetary values in economic evaluations of health interventions. The current paper compares the DCE method with a follow-up open-ended CV question in terms of willingness-to pay for perinatal care. The main aim is to examine consistency between the two methods. In particular, it is examined whether individuals who are willing to pay relatively more in the open-ended CV question are also willing to make larger trade-offs in the DCE. The methods are also compared in terms of mean WTP and in terms of the relationship between individuals' characteristics and WTP.

Face to face interviews were held with 292 women. The results show that the mean WTP derived from the CV question is substantially lower than the mean derived from the DCE. The results suggest that individuals who are willing to pay relatively more in the open-ended CV question were also willing to make relatively larger trade-offs in the DCE. High levels of consistency were achieved when examining whether participants chose the package in the DCE identified as their optimal package in the follow-up question. Income has a positive and significant effect on individuals' WTP in the CV method but no effect in the DCE.

## 1. Introduction

Procedural invariance is a fundamental assumption of the stated preference approach and assumes that normatively equivalent elicitation methods should yield the same preference order. If stated preferences do vary by elicitation method, it is unclear which method best approximates individuals' underlying preferences. Procedural invariance has been researched extensively within the contingent valuation (CV) literature. A common finding is that the closed-ended methods produce higher estimates of willingness to pay compared to open-ended or payment card methods (Carson et al., 2001). This has also been demonstrated within the health domain (see for example Ryan *et al.*, 2004, Frew *et al.*, 2004, Frew *et al.*, 2003). The violation of procedural invariance has undermined the application of WTP values in economic evaluation of health interventions. For example, Cookson (2003, p. 892) argues that "In a health care context, it is thus highly implausible to interpret responses to WTP questions in terms of a well-behaved individual utility function of the kind required by standard welfare economic theory".

Relatively few studies have included a Discrete Choice Experiment (DCE) in the comparison. The DCE is becoming increasingly popular within health economics and further evidence on procedural invariance of this technique with other methods is therefore desirable. Two previous studies compared a DCE with a dichotomous choice method (Hanley *et al.*, 1998, Ryan, 2004) and found similar WTP estimates. The current paper compares a DCE with an open-ended CV question. The open-ended method was used as it is relatively popular within health economics and because it provides individual specific estimates of willingness to pay allowing a more robust comparison with the DCE. Payment cards are usually provided with open-ended questions in order to make the question easier to answer but this comes at the cost of introducing a potential range bias. A payment card was not used in the current study as the open-ended CV question followed a DCE and it can therefore be argued that individuals were familiar with the decision task.

Several reasons have been put forward in the literature as to why different methods of eliciting preferences may produce different results. The main focus has been on differences in incentives for individuals to act strategically (Carson, 1997). It is

argued that the dichotomous choice method is most incentive compatible. Several potential biases have been identified with respect to the different methods including the impact of ‘yeah saying’ (Holmes and Kramer, 1995) and choice of bid vector in dichotomous choice methods (Cooper and Loomis, 1992), a starting point bias in open-ended method using bidding game, and range bias in open-ended method using payment scale (Mitchell and Carson, 1989). There are also clear differences in the methods used to analyse the data. Whilst analysing open-ended data is relatively straightforward, the techniques used to analyse closed-ended data generally require strong assumptions of the underlying value/utility function. Violations of these assumptions may result in biased estimates from closed-ended methods (Halvorsen and Sælensminde, 1998). Differences in error variance (or scale parameter) across elicitation methods have also been highlighted (Louviere *et al.*, 2002). There is some evidence that once random component variability is taken into account, mean estimates are similar across methods. Ratcliffe (2000) identified a potential framing effect in that DCEs generally use the label ‘cost’ whilst other methods use the term willingness to pay. Finally, the psychology literature suggests that individuals employ different decision heuristics depending on the elicitation method used (Tversky *et al.*, 1988).

The different methods are usually compared in terms of mean willingness to pay values and this is also done in the current paper. Given the large range of potential biases present, it is perhaps not surprising that the methods produce different estimates. The main focus of this paper is therefore on testing for consistency between the methods. This is investigated by examining whether individuals who are willing to pay relatively higher amounts in open-ended questions also make relatively larger trade-offs in a DCE. The paper also examines theoretical validity through exploring relationship between willingness to pay, income, and other characteristics of the individuals.

## **2. Methods**

The study was conducted alongside the Community Perinatal Care trial which compared standard perinatal care with two intervention arms within a community-

based randomised trial. The first intervention arm involved standard care plus appointments with a Community Nurse Specialist. The second intervention arm augmented the specialist nursing care with home visits by trained lay-advisors. The main aim of the DCE was to elicit women’s preferences for the different types of care to be incorporated into the economic evaluation.

In total, 292 women were recruited to the current study by telephone around one year after birth (the trial finished eight weeks after birth). Face to face interviews were held at a location convenient to the participating mothers, either in their own home or at the university. Appendix 1 shows the descriptive statistics of the sample.

### 2.1. DCE

Four attributes were included in the DCE: appointments with a nurse specialist; home visits (these were the services offered in the CPC trial); home-help after birth; and costs. The levels for nurse appointments and home visits were based on the average and range offered in the trial. The choice of levels for the cost attribute is more arbitrary (Ratcliffe, 2000). The levels were initially based around the estimated average cost of the services and were revised after a postal pilot study. Table 1 shows the attributes and levels used in the DCE.

**Table 1. Attributes & levels**

<b>Attribute</b>	<b>Levels</b>
Nurse	0, 1, 3, 5 appointments
Home visitor	0, 1, 2, 4 visits
Home-help	0, 2, 3, 5 hours per week*
Costs (CAD)	\$0, \$75, \$140, \$250

\* for the first 4 weeks after birth

Appendix 2 shows an example of the discrete choice. Participants received a detailed description of the three services. They were also informed that the cost associated with the perinatal services is a one-time payment which covers all of the services provided in the package.

The experimental design was developed by Deborah Street (UTS, Sydney) using the methods outlined in Burgess and Street (2003). The design allows for a 2-way interaction between nurse appointments and home visits. The total number of discrete choices in this design is 48. A block design was used in order to bring the number of choices for each participant down to a more manageable level of 16 choices. The 48 discrete choices were randomly allocated across the 3 versions.

Conditional logistic regression is used to analyse the discrete choice data. To investigate the possibility of non-linearity, utility functions are modelled using second-degree polynomials. The non-parametric method of bootstrapping is used to estimate confidence intervals for the marginal rates of substitution (Efron, 1979).

## **2.2. Open-ended CV**

After the DCE participants were presented with the open-ended CV question. Participants were first asked to identify their optimal package in terms of nurse appointments, home visits and home-help. It was stressed that they could choose as many or as few as they preferred, that is, that the numbers were not restricted to those used in the DCE. Once they stated their optimal package, they were asked how much they were willing to pay for their identified optimal package. If they returned a value of \$0, they were asked to indicate why they chose zero. This allows identification of protest answers versus true zeros.

Tobit regression is used to analyse the open-ended data because the WTP values are censored at zero. WTP values are modelled as a function of the number of nurse appointments, number of home visits, and hours of home-help identified in the optimal package, and individuals' characteristics described in section 2.3.3.

## **2.3. Methods of comparison**

The two methods are compared in terms of mean WTP values, consistency between the two methods and in terms of theoretical validity.

### **2.3.1. Mean WTP values**

The conditional logit and Tobit regression models are used to calculate mean values for different service configurations. A t-test is used to test whether any of the differences in WTP values between the two methods are statistically significant.<sup>1</sup>

### **2.3.2. Consistency between methods**

The hypothesis to be tested is whether individuals who are willing to pay relatively more in the open-ended CV question are also willing to make relatively larger trade-offs in the DCE. The WTP values in the open-ended CV question were elicited for the participants' own ideal package which varied across individuals. This means that relatively higher amounts in the CV question could indicate a greater willingness to pay and/or simply a larger number of services identified in the optimal package. To allow for the latter, the Tobit regression model is used to estimate individual specific predicted WTP values ( $\hat{\$}_i$ ). The relative difference between the predicted WTP value and the actual WTP value indicates whether participants are willing to pay relatively more whilst taking into account their identified optimal package and their characteristics such as income ( $(\$_i - \hat{\$}_i)/\hat{\$}_i$ ). An interaction term of this variable and the cost attribute is included in the DCE. The hypothesis that individuals who are willing to pay relatively more in the open-ended CV question are also willing to make relatively larger trade-offs in the DCE is accepted if the coefficient on the interaction is positive and statistically significant.

For a sub-sample of participants, consistency can also be checked on an individual level. It is examined whether individuals choose their optimal package if it was presented to them in the DCE and the costs of the DCE package were less than or equal to their willingness to pay value.

The follow-up question allows a further test of consistency, namely between the optimal package identified through the DCE and the optimal package identified directly. It should be noted that this is not part of testing consistency between

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<sup>1</sup> It is recognised that this comparison fails to take potential differences in response variability into account. The use of more sophisticated econometric techniques is part of future research.

different methods of eliciting WTP (since it only examines consistency in terms of number of services preferred). Participants are grouped according to the number of nurse appointments, the number of home visits and the hours of home-help in their optimal package. The DCE model is then segmented by the different sub-groups. The hypothesis is that the higher the number of services stated in the optimal package, the larger the coefficients on nurse appointments, home visits and home-help in the DCE model. The optimal number of each of the services is estimated using the DCE results and compared to the number stated in the optimal package.

### ***2.3.3. Theoretical validity***

To assess theoretical validity of the two techniques, the relationship between WTP and individuals' characteristics is explored. The characteristics that are examined are: household income (dummy variables:  $< \$40,000$  and  $\geq \$80,000$ ), whether it is their first child (dummy variable: first child) and experience with the service (dummy variables: arm 2&3; arm 3). It is hypothesised that WTP increases as a function of income. It is also hypothesised that women are willing to pay more for the nurse appointments and the home visits if it is their first child. Evidence suggests that experience with the service influences individuals' preferences (Ryan and Ubach, 2003).

## **3. Results**

### **3.1. DCE**

Table 2 show the regression results for the DCE. The coefficients on nurse appointments and home-help are positive and significant indicating that individuals place a positive value on these services. The squared terms are significant and negative reflecting diminishing marginal utility. Cost is negative indicating that the higher the cost of the package the lower the utility associated with it. The coefficient on Home visitor is not significant in the full model and negative in the reduced model indicating that women do not value home visits. The optimal package consists of 3 nurse appointments and 5 hours of home-help. On average, women are willing to pay \$280 for this optimal package.



**Table 2. Regression results DCE**

	Full model		Reduced model	
	b	t-value	b	t-value
Nurse	0.309	7.20	0.317	7.55
Nurse <sup>2</sup>	-0.050	-6.01	-0.050	-6.02
Home visitor	0.086	1.66	-0.066	-4.37
Home visitor <sup>2</sup>	-0.039	-3.34	-	-
Nurse × Home visitor	0.002	0.19	-	-
Home-help	0.671	17.47	0.694	18.67
Home-help <sup>2</sup>	-0.074	-10.50	-0.078	-11.20
Cost	-0.007	-26.69	-0.007	-27.36
N	14016		14016	
Pseudo R <sup>2</sup>	0.163		0.162	
Count R <sup>2</sup>	0.571		0.566	

### 3.2. Open-ended CV

In total, 25 participants were not willing to pay for the optimal package. Seven out of 25 could be identified as giving protest answers. They were indicating that the health service should pay for the services. Table 3 reports summary statistics of the optimal package and the WTP values for the full sample and the sample excluding protest answers.

**Table 3. Summary statistics for optimal package and CV WTP values**

	Full sample (N=292)		Excluding protest answers (N=285)	
	Mean (median)	95% CI	Mean (median)	95% CI
Nurse appointments	3.4 (3)	3.1-3.7	3.4 (3)	3.1-3.7
Home visits	2.0 (2)	1.8-2.3	2.0 (2)	1.8-2.2
Home-help	5.3 (4)	4.8-5.9	5.4 (4)	4.9-6.0
WTP	\$146 (\$120)	133-159	\$149 (\$125)	137-162

### 3.3. Comparison

#### 3.3.1. Mean WTP values

Table 4 shows the comparison of mean WTP values for the two methods. Mean WTP is estimated for two different optimal packages, namely the optimal package identified in the DCE and the optimal package identified in the direct question. The

main difference between the optimal packages is in terms of home visits. In case of both packages, the mean WTP is higher when estimated using the DCE as compared to the open-ended CV question. The differences in mean WTP are statistically significant.

**Table 4. Comparison of mean WTP**

Package	DCE		CV		t-test
	Mean	95% CI	Mean	95% CI	
<i>Optimal package from DCE results</i>					
3 nurse appointments/ 0 home visits/ 5 hrs of home-help	\$220	202-241	\$142*	128-154*	6.73
<i>Direct optimal package</i>					
3 nurse appointments/ 2 home visits/ 5 hours of home-help	\$205	189-225	\$149**	137-162	5.06

\* estimation based on regression results reported in Table 7; \*\* estimation based on raw data

### 3.3.2. Consistency between methods

Appendix 3 shows the DCE regression results for the model which includes the interaction term of cost and the relative difference between predicted and actual WTP in the OE CV question. The coefficient of the interaction term is as hypothesised. That is, individuals who are willing to pay relatively more in the direct CV question also make larger trade-offs in the DCE. To illustrate the impact, WTP values are estimated for the package consisting of 3 nurse appointments, 2 home visits and 4 hours of home-help using the DCE. For individuals whose actual willingness to pay value from the CV question was 50% higher than their predicted WTP value, the WTP value derived through the DCE is \$366. For those individuals whose actual WTP value was 50% less than their predicted value, the WTP value derived from the DCE is \$238.

Consistency can be tested on an individual level for 23 participants (and 100 DCE choices). Five participants preferred to have none of the services. In 71 out of 80 (89%) DCE choices they also chose the package which offered none of the services.

Consistency can also be tested with respect to a further 20 DCE choices (and 18 participants). In those cases, the package provided in the DCE was equal to the optimal package identified in the follow-up question and the costs were less than or equal to the WTP value in the CV question. In 19 out of 20 (95%) DCE choices the participant chose the same package.

Finally, consistency between the DCE and the follow-up question is assessed in terms of the optimal package. The model in Appendix 3 also includes the DCE interaction terms of the different services with the number stated in the direct follow-up question. The sign and relative sizes of the coefficients are as hypothesized. For example, the higher the number of nurse appointments participants indicated in the direct optimal package question, the larger the coefficient on nurse appointments in the DCE. Table 5 reports the optimal number of each of the services identified through the DCE. For nurse appointments and home visits, there is a very close match between the number indicated in the direct optimal package question and the DCE results for the different groups. With respect to hours home-help, the DCE results indicate a stronger preference than stated in the direct optimal package question.

**Table 5. Comparison of optimal package**

Nurse			Home visits			Home-help		
Direct	DCE	[95% CI]	Direct	DCE	[95% CI]	Direct	DCE	[95% CI]
0	0.10	[-1.65-0.99]	0	-1.59	[-10.49- -0.37]	0	2.23	[1.48-2.91]
1 or 2	1.62	[0.80-2.02]	1 or 2	1.43	[-0.57-2.13]	1 or 2	3.37	[2.99-3.83]
3 or 4	3.71	[3.12-4.75]	3 or 4	3.07	[2.12-6.00]	3 or 4	4.26	[3.89-4.76]
>4	4.56	[3.88-5.97]	>4	3.65	[2.54-8.23]	5	4.99	[4.49-5.63]
						>5	4.86	[4.39-5.46]

### 3.3.3. Theoretical validity

Tables 6 and 7 report the regression results for the DCE and open-ended CV exploring the relationship between individuals' preferences and their characteristics. The most important difference between the DCE and the CV question is in terms of income. Whilst there is a statistically significant relationship between income and the open-ended CV WTP values, no relationship was found between the cost attribute and income in the DCE.

**Table 6. DCE regression results including individuals' characteristics**

	Full model		Reduced model	
	b	t-value	b	t-value
Nurse	0.201	4.40	0.202	4.54
Nurse <sup>2</sup>	-0.051	-6.09	-0.050	-6.08
Nurse × first child	0.064	3.26	0.071	3.83
Nurse × arm 2&3	0.122	6.11	0.119	6.01
Home visits	0.103	1.89	0.125	2.49
Home visits <sup>2</sup>	-0.041	-3.44	-0.040	-3.42
Home visits × first child	0.036	1.38	-	-
Home visits × arm 3	-0.095	-3.53	-0.090	-3.38
Nurse × home visits	0.003	0.31	-	-
Home-help	0.677	17.55	0.674	17.74
Home-help <sup>2</sup>	-0.075	-10.52	-0.074	-10.50
Costs	-0.008	-19.75	-0.007	-26.15
Costs × low income	0.001	1.81	-	-
Costs × high Income	0.001	1.08	-	-
Costs × no answer income	-0.001	-1.81	-0.002	-2.50
N	14016		14016	
McFadden R <sup>2</sup>	0.170		0.169	
Count R <sup>2</sup>	0.575		0.577	

In contrast, whether women had their first child and whether or not they experienced the different services, was statistically significant in the DCE but not with respect to the open-ended CV method. It should be noted though that the Tobit regression of the open-ended CV data examines the impact of these variables on WTP only whilst the DCE examines the impact on individuals' preferences more generally.

#### 4. Discussion

This paper compared a DCE with the open-ended CV method. Consistent with the growing literature on the violation of procedural invariance, the mean estimates produced by the closed-ended method (the DCE) were larger than the mean produced by the open-ended CV question and the differences were statistically significant. The main aim of the paper was to examine the consistency between the methods. The results suggest that individuals who are willing to pay relatively more in the open-ended CV question were also willing to make relatively larger trade-offs in the DCE.

High levels of consistency were achieved when examining whether participants chose the package in the DCE identified as their optimal package in the follow-up question. The results on theoretical validity were mixed in that income was a significant predictor of WTP in the open-ended CV but not in the DCE. However, the impact of whether it was their first child and experience of the service was as hypothesised in the DCE but not significant in the open-ended CV.

The study also showed that the DCE produced highly consistent results with the directly identified optimal package of services. This increases confidence to be placed on the estimates produced by the DCE. Whether the same holds for the WTP values produced by the DCE is unclear since the values were different from the directly elicited willingness to pay values and since income did not impact the disutility associated with the cost attribute.

**Table 7. Tobit regression results OE CV**

	Full model		Reduced model	
	b	t-value	b	t-value
Constant	35.43	1.74	38.23	2.29
Nurse	19.39	2.58	7.93	2.88
Nurse <sup>2</sup>	-1.31	-1.64	-	-
Nurse × first child	-0.35	-0.07	-	-
Nurse × arm 2&3	-4.09	-1.15	-	-
Home visits	-7.85	-0.93	-	-
Home visits <sup>2</sup>	-0.43	-0.70	-	-
Home visits × first child	5.69	0.77	-	-
Home visits × arm 3	-5.84	-1.11	-	-
Nurse × home visits	1.73	1.20	-	-
Home-help	16.60	5.57	16.73	5.60
Home-help <sup>2</sup>	-0.33	-3.48	-0.33	-3.42
Low income	-46.51	-2.26	-51.91	-2.54
High Income	35.76	2.50	40.08	2.81
No answer income	-42.39	-1.98	-45.26	-2.14
N	292		292	
Pseudo R <sup>2</sup>	0.026		0.023	

One of the limitations of this study is that a within-sample design was used. The values provided in the follow-up questions may have been biased by the values presented in the DCE. Version of the questionnaire was included in the Tobit regression model and was not statistically significant. However, this is a rather weak test since there were only small differences in terms of how often each of the levels were presented to participants in the different versions of the questionnaire.

Research into the different biases present continues to be an important line of enquiry. Given that the methods appear to be consistent, identifying and quantifying biases and subsequently employing corrective procedures should in principle achieve convergence of the WTP estimates. Moreover, once it is decided which biases we *should* correct for, debiasing will ensure that the estimates obtained from the different methods more accurately reflect individuals' preferences (Fischhoff, 1982).

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## Appendix 1. Descriptive statistics of sample

	<b>Mean</b>	<b>Range</b>
Age	31.4 years	(20-48)
Age of child	15.2 months	(13-20)
	<b>N</b>	<b>%</b>
First child	150	51.4
Highest level of education		
High school	53	18.2
Post-secondary	114	39.0
University	125	42.8
Household income		
<\$40,000	23	7.9
\$40,000 - \$79,999	113	38.7
≥ \$80,000	109	37.3
Prefer not to answer	33	11.3



## Appendix 2. Question formats

### Example of discrete choice:

Choice 1	PACKAGE A	PACKAGE B	
Nurse	5 appointments	3 appointments	
Home visitor	1 visits	2 visits	
Home help	5 hrs per week	3 hrs per week	
Cost to you	\$0	\$250	
Which package would you choose? (✓ one only)	A <input type="checkbox"/>	B <input type="checkbox"/>	Neither <input type="checkbox"/>

### CV question:

**What is your ideal package?**

Nurse	_____ appointments
Home visitor	_____ visits
Home help	_____ hrs per week

**How much are you willing to pay for this package?**

### Appendix 3. DCE results by stated preference in follow-up question

	b	t-value
Nurse × nurse <sub>direct=0</sub>	-0.021	-0.36
Nurse × nurse <sub>direct=1 or 2</sub>	0.187	3.92
Nurse × nurse <sub>direct=3 or 4</sub>	0.460	9.40
Nurse × nurse <sub>direct&gt;4</sub>	0.571	11.70
Nurse <sup>2</sup>	-0.062	-6.97
Home visits × home visits <sub>direct=0</sub>	-0.188	-3.08
Home visits × home visits <sub>direct=1 or 2</sub>	0.143	2.49
Home visits × home visits <sub>direct=3 or 4</sub>	0.327	5.22
Home visits × home visits <sub>direct&gt;4</sub>	0.385	5.56
Home visits <sup>2</sup>	-0.054	-4.29
Nurse × home visits	0.006	0.60
Home-help × home-help <sub>direct=0</sub>	0.368	6.12
Home-help × home-help <sub>direct=1 or 2</sub>	0.587	12.76
Home-help × home-help <sub>direct=3 or 4</sub>	0.773	17.77
Home-help × home-help <sub>direct=5</sub>	0.927	20.28
Home-help × home-help <sub>direct&gt;5</sub>	0.931	20.15
Home-help <sup>2</sup>	-0.092	-12.15
Costs	-0.009	-28.11
Costs × WTP <sub>CV_relative</sub>	0.004	11.26
Costs × WTP <sub>CV_relative2</sub>	-0.0003	-5.67
N	14016	
McFadden R <sup>2</sup>	0.267	
Count R <sup>2</sup>	0.643	