UNIVERZITA KARLOVA V PRAZE

Service contract for the European Chemicals Agency No. ECHA/2011/123

Appendix: Willingness to pay for avoiding respiratory sensitisation outcomes

Vojtěch Máca

(with a contribution by Milan Ščasný)

Charles University in Prague (Environment Center)

September 2014

Willingness to pay for avoiding asthma discomfort

This chapter reports on analysis of willingness to pay for avoiding asthma discomfort using data from stated preference study conducted in FP6 project HEIMTSA. Unlike the original HEIMTSA report[1] that is based on main wave data (comprising 6 countries), here we include also data from additional wave conducted in 2012 in the Czech Republic, Slovakia and the UK.

Previous research

The number of studies on socioeconomic burden of asthma has grown over the last years. Most of these studies dealt with cost-of-illness (with or without accounting for indirect costs) but only a handful of stated-preference studies were conducted to elicit WTP to avoid asthma episodes/symptoms.

In a recent study Brandt et al. (2012) estimated a mean WTP for avoiding single day with symptoms at USD 9.75 to 11.39 (EUR_{2010} 7.7 to 9) and at USD 20.4 to 23.82 (EUR_{2010} 16.1 to 18.8) for avoiding a day with bad symptoms. Using a carefully designed survey instrument they find that symptom frequency is positively associated with WTP, but not significantly and the coefficient is smaller than for other attributes of health status and attitudes and beliefs related to asthma. It is hypothesised that WTP depends less on objective severity measures and more on attitudes and beliefs.

Blomquist et al. (2011) elicited WTP for asthma control and found that annual value of asthma control decreases from USD 4055 by parents of children aged 4 to USD 2130 by parents of children aged 17 years, then jumps to USD 3908 for adults aged 18, declines until the age of 60 years to USD 1744 and then rises to USD 2159 for adults aged 81. Interestingly, they found that familiarity with asthma is not significant covariate of WTP. Previous study by O'Conor and Blomquist (1997) reports a WTP of USD 67-89 (EUR_{2010} 53-70) per bad symptom day avoided and USD 36-47 (EUR_{2010} 28.5-37) per day of symptom day avoided.

Navrud (2001) elicited WTP to avoid additional days of major asthma attacks for asthmatics and non-asthmatics (the asthmatics' subsample was however small, with 25 and 30 respondents in each of two subsamples). Mean WTP to avoid one additional day of asthma attacks was about NOK 1,162 (EUR_{2010} 137) among asthmatics (although median was much lower at NOK 200) and about NOK 560 (EUR_{2010} 66) among non-asthmatics, in subsample offered avoidance of 14 days of major asthma attacks the WTP was NOK 1,772 (EUR_{2010} 209) and NOK 1,679 (EUR_{2010} 198) among asthmatics and non-asthmatics respectively.

An earlier study by Rowe and Chestnut (1984) gives an estimated WTP for avoiding a single day of bad asthma symptoms of USD 22 (EUR_{2010} 17.4) In US EPA benefit-cost analyses an asthma exacerbations are valued at USD 50 per incidence (1990 income level), based on the mean of average WTP estimates for the four severity definitions of a "bad asthma day," described in the abovementioned Rowe and Chestnut study.

Kim et al. (2011) estimated financial burden of asthma in Korea, including intangible costs measured as WTP to improve quality of life up to a "normal" level. Mean WTP was estimated at USD 151.9 per month, and the total quantified intangible costs were almost the same as the sum of quantified direct and indirect costs.

Blumenschein and Johannesson (1998) explored relationship between asthma impact on quality of life and willingness to pay in asthmatic patients. They found mean health utility between 0.68 and 0.91

[1] Presentation of unit values for health-endpoints: country-specified and pooled, Deliverable D4.1.3, available from http://www.heimtsa.eu/language/en-GB/Results/Deliverables.aspx

(depending on quality of life instrument used); mean WTP was between USD 200 and USD 350 per month for asthma cure. In a similar fashion Zillich et al. (2002) explored relationship between WTP, quality of life and disease severity measures in patients with asthma. They found that WTP is significantly related to both objective and subjective disease severity measures – mean monthly WTP for cure for objective disease severity was USD 90, USD 131 and USD 331 for mild, moderate and severe asthma, and for subjective disease severity it was USD 48, USD 166 and USD 241 for mild, moderate and severe asthma, respectively.

Questionnaire

The valuation of asthma discomfort started with a set of questions on frequency of asthma attacks and medication use. The WTP elicitation was preceded by a screening question: "*Would you consider paying something to avoid the need to use medicine(s) to relieve your asthma symptoms?*". Those who responded affirmatively were repeatedly offered randomly generated amounts of payment, which they were asked to accept or reject. For those who refused to pay anything to avoid the illness, a debriefing question was asked to help identify whether they express their "true zero" willingness to pay or protest against certain aspect of the contingent scenario (i.e. "protest zero").

If a respondent said 'yes' then his/her willingness-to-pay was elicited using an iterative bidding format in the multiple bounded discrete choice exercise (see e.g. Bateman et al., 1995). We opted for this format since the use mixed mode (CAPI and CAWI) made it impossible to use traditional supporting visuals in paper form such as payment cards that are used to facilitate ease of comprehension of the WTP exercise. Furthermore the absence of an interviewer meant that the elicitation format had to be easily understandable and had to work in any web browser.

The payment was presented as a lump-sum and the respondent was asked whether s/he would almost certainly (i.e. s/he is 95% sure) pay this sum. We took advantage of the computer-assisted survey in that the bid generation was randomized to allow for controlling of a possible starting bid bias. The range for the bidding game was set at 0-200 Euros.[2] To speed up the convergence of the respondent's WTP interval the initial bid was generated randomly from the interval that was trimmed by 15% of the range between minimum and maximum on each side.[3] The next bid was then generated based on the acceptance or rejection of the first bid. If accepted, the lower boundary for the generation of the next bid (i.e. $WTP_{lower\ bound}$) was set equal to the accepted bid and the upper boundary was retained. If the bid was rejected then the rejected bid was recorded as the upper boundary (i.e. WTP_{max}) and the lower

[2] In order to safeguard equal ranges of bids in the bidding-game across the countries, the bids were adjusted using purchasing parity power (PPP) based on a OECD's Purchasing Parities for GDP index and the bids were randomly generated in 'generic Euros' and then converted to respective national equivalents:

Purchasing parity power rates	
CZ / Euro	17
UK / Euro	0.8
FR / Euro	1
DE / Euro	1
EL / Euro	0.85
NO / Euro	10
SK / Euro	0.65

[3] Though the 15% trimming was chosen arbitrarily it helped much in narrowing the range of the respondent's WTP in 5 rounds of dichotomous choice without substantially compromising the randomness in the generation of bids.

boundary was retained. The range for the second bid was trimmed similarly to the first bid (i.e. by 15% of the range between minimum and maximum on each side). This algorithm was repeated three more times (i.e. 5 bids in total) unless the interval between the recorded $WTP_{lower\ bound}$ and $WTP_{upper\ bound}$ was less than rounding term,[4] which then made the algorithm stop.
In the next screen the final range (for e.g. '*So you would almost certainly pay 78 but not 133 £.*') was shown and an open-ended question on the maximum WTP was asked. When the WTP amount stated in the open-ended question was out of the range of the interval from dichotomous choice – 'The amount you just indicated is out of the range that you have chosen earlier for avoiding this illness. Is this the maximum amount you are most likely willing to pay?'

Survey

The respondents were recruited based on quota sampling. The quotas were age, gender, education and size of residence and region (except for Greece and Norway where interconnected quotas on gender and age and an individual quota on region were applied to achieve the target sample size).
Sample sizes were approximately N=1900 per country for the CAWI method and N=1000 for the CAPI sample in the Czech Republic in the first wave and N=1900 for CAPI sample in Slovakia. The response rates ranged between 83% (Czech R.) and 18% (Greece).

Results

The respondents to the survey were sampled using predefined quotas on gender, age, education and size of residence.[5] The proportion of asthmatics (defined as those respondents who gave positive answer to the question '*Has a doctor ever given you a diagnosis of one or more of the following illnesses? – Asthma'*), is shown in the following table. In total 1 838 respondents have indicated they were given the asthma diagnosis, but questionnaires were subsequently excluded for incompleteness.

Table 1 – Share of asthmatics in survey samples

country sample	share of asthmatics		no of asthmatics
	main wave	follow-up	
CZ	7.6%	12.8%	427
Germany	7.6%		156
UK	15.9%	17.7%	590
France	8.7%		161
Greece	7.4%		134
Norway	13.5%		270
Slovakia		5.7%	100

The following sample summarizes asthmatics' sub-sample socioeconomics characteristics. We observe higher proportion of female asthmatics in all countries but Slovakia what seems to be in line with epidemiological findings that while more pubescent males have asthma than females but the roles

[4] The randomly generated amounts were rounded as follows – up to €50 to count numbers, between €50-500 to tens, and above €500 to hundreds.

[5] Unfortunately, the internet panel used in Greece had insufficient coverage of people above 55 years, and therefore the quotas were adjusted to be representative of population aged 18-55.

change in young adulthood when female asthmatics outnumber male asthmatics (e.g. Lötvall et al., 2009).

Table 2 – Descriptive statistics of asthma sub-sample

	Czech	German	English	French	Greek	Norwegian	Slovak
age (mean)	38.9	42.9	41.4	40.4	32.3	39.7	38.4
male (proportion)	36.1%	37.8%	43.6%	39.1%	44%	37.8%	49%
married (proportion)	48.5%	59.6%	59.3%	65.2%	32.8%	59.6%	51%
tertiary education (proportion)	8.7%	19.2%	35.8%	14.9%	67.7%	89.7%	24%
household size	3.2	2.5	2.6	2.8	3.3	2.6	3.6
household income (mean PPP EUR)	1612	2532	3562	2686	1208	3698	1782
active smoker	34.9%	30.8%	24.7%	39.8%	36.6%	42.6%	23%
regularly suffers from asthma attacks	25.3%	48.1%	23.9%	34.8%	20.9%	14.1%	32.0%
- how often in last 3 months (median)	7.8	14.1	11.1	11.3	8.2	5.2	3.9

Zero WTP and protesters

Share of respondents who do not consider paying for avoiding illness is shown in the following table.

country	share of "true-zero"	Share of protesting respondents
Czech	19%	2%
German	49%	3%
English	32%	4.5%
French	31%	7%
Greek	22%	1.5%
Norwegian	35%	2%
Slovak	32%	3%

The share of protest responses to asthma discomfort scenario was lower compared to other endpoints with only about 2% protesting rate in the pooled sample.

Out of 1838 respondents who indicated that they have been diagnosed with asthma, there are almost 40% of those who do not consider paying anything for avoiding the discomfort caused by an asthma attack, although the share is significantly different between countries ranging from 22% in Greece to 53% in the UK. The following table summarizes the most important reasons for such responses.

Table 3 – Most important reasons for refusal of paying to avoid discomfort from asthma medication

Why would you not be willing to pay anything?

	Czech	German	English	French	Greek	Norwegian	Slovak
N	*75*	*77*	*168*	*50*	*29*	*94*	*35*
My asthma symptoms are not severe enough to pay to avoid	40.0%	22.1%	47.0%	28.0%	55.2%	55.3%	37.1%
I don't feel any discomfort from using medicine(s) to relieve my asthma symptoms	30.7%	32.5%	31.0%	18.0%	13.8%	13.8%	11.4%
My health expenses are already too high	12.0%	9.1%	1.2%	12.0%	3.4%	4.3%	11.4%
I can't afford this payment	12.0%	29.9%	16.1%	20.0%	17.2%	7.4%	31.4%
I don't trust the information I have been given	1.3%	5.2%	1.2%	14.0%	3.4%	4.3%	8.6%
Another reason: (please specify)	4.0%	1.3%	3.6%	8.0%	6.9%	14.9%	0%

The most frequent reason for 'opt-out' is *not severe enough to pay to avoid*, followed by *don't feel any discomfort from using medicine(s)*. Only "*I don't trust the information*" is treated as a protest (along with two similar open-ended statements under "another reason" option), the rest as legitimate zeros.

Willingness to pay

The following table reports descriptive statistics on the willingness-to-pay per person per country for avoiding asthma discomfort, estimated as the midpoint of the interval between the highest accepted and lowest rejected bids after last round of bidding game. In the open-ended WTP responses a few extreme values were identified and trim the upper range of WTP at 97.5th percentile (i.e. at about €500).

Table 4 – Descriptive statistics of elicited WTP

	Czech	**German**	**English**	**French**	**Greek**	**Norwegian**	**Slovak**	**pooled**
				interval data				
N	*408*	*151*	*549*	*150*	*132*	*265*	*88*	*1743*
mean	42.5	50.3	26.6	52.1	80.4	77.6	50.7	47.63
median	14	16.5	0	29.75	61.75	43.5	17	15
std. dev.	59.2	64	50.6	60.3	69.5	80.8	66.7	65
				open-ended data				
N	*409*	*148*	*533*	*149*	*128*	*253*	*94*	*1714*
mean	39.95	46.08	23.51	49.93	83.66	87.94	53.35	47.32
median	11.47	14	0	23.25	57.67	36.36	17.69	12
std. dev.	64.35	61.84	51.06	66.24	90.60	118.34	86.45	78.18

Consistency between WTP from bidding game and open-ended question

The sequence of WTP elicitation presented multi-bounded dichotomous choice (DC) first, followed by open-ended question asking for maximum WTP. In addition, when asked the open-ended question (OE), the respondent was informed about the final interval elicited in the bidding game and in the case that s/he stated an amount outside of this interval s/he was reminded that this amount is outside of the interval and asked whether this amount is the maximum s/he is most likely willing to pay. Out of 326 respondents who stated open-ended WTP outside of the final dichotomous choice interval (19% of asthma subsample), 114 stated lower and 140 stated higher open ended WTP than interval from bidding game.

Parametric and non-parametric models of WTP

We use two modelling approaches, non-parametric and parametric, to estimate WTP. The two-part model that is well equipped to deal with large proportion of zero answers ('non-participation') as over 40% of respondents (and more than half of the respondents in UK) stated that they won't consider paying for avoiding such illness.

Table 5 – Estimated willingness to pay (€ per case)

	Czech	German	English	French	Greek	Norwegian	Slovak	pooled
interval non-parametric								
mean	41.07	48.43	26.10	50.28	78.85	76.74	48.38	46.76
median	13	15	0	29	60	40	17	14
interval parametric								
mean	46.94	53.45	28.17	55.94	85.18	86.75	55.08	53.22
median	25.56	39.20	15.09	33.86	62.30	56.76	31.56	29.94
open-ended parametric								
mean	43.7	49.1	24.7	51.4	86.2	101.2	57.0	52.2
median	21.7	34.9	12.7	31.5	58.7	54.7	28.8	26.7

Validity testing

We run several two-part models to explore the effect of variables conventionally deemed to be correlated to willingness to pay, such as income or education. We report two models, the first one with larger set of covariates, the second one with country dummies only (CZ as contrast); we use the same covariates in both parts of the two part model.

Table 6 - Descriptive statistics of explanatory variables

name	Description	mean	(s.d.)
good health	1 if respondent considers his/her health above his/her peers	0.21	(0.41)
other chronic illness	1 if respondent suffers from other chronic illnesses	0.3	(0.46)
active smoker	1 if respondent is an active smoker	0.32	(0.47)
regular attacks	1 if respondent stated that s/he regularly suffers from asthma	0.26	(0.44)
regular medication	1 if respondent regularly use medicine to relieve asthma	0.61	(0.49)
reference income	reference income (individual or household)	7.21	(1.51)
age	age of respondent	39.76	(13.98)
male	1 if respondent is male	0.40	(0.49)
married	1 if respondent is married	0.55	(0.5)
college	1 if respondent graduated from college/university	0.36	(0.48)
household size	number of household members	2.87	(1.35)

A two-step model (Model 1) consists of a model of participation in WTP exercise (probit model) and log-normal regression (Model 2) on data for respondents who respondent positively to the participation question. As the literature suggests the use of two-part model should be preferred for estimation of WTP with higher proportion of non-participants (also called 'spike'); also the WTP estimates from two-part models are close to non-parametric lower bound WTP estimates.

Table 7 - Regression models of interval WTP

	Model 1 - participation (probit)				**Model 2 – positive WTP (lognormal – positive)**			
	full model		**simple model**		**full model**		**simple model**	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
constant	-9.44E-02	1.76E-01	0.28867 ***	0.06158	3.84E+00 ***	1.79E-01	3.7304 ***	0.0644
German	-3.37E-01 *	1.43E-01	-0.2726 *	0.11774	6.51E-01 ***	1.49E-01	0.5829 ***	0.1311
British	-4.58E-01 ***	9.82E-02	-0.43363 ***	0.08047	-2.00E-01	1.07E-01	-0.2073 *	0.0918
French	1.35E-01	1.42E-01	0.2056 .	0.12025	1.75E-01	1.32E-01	0.0925	0.1162
Greek	4.29E-01 *	1.69E-01	0.49568 ***	0.13602	6.04E-01 ***	1.47E-01	0.6245 ***	0.1183
Norwegian	1.38E-01	1.36E-01	0.10165 ***	0.09971	7.73E-01 ***	1.33E-01	0.7202 ***	0.1003
Slovak	1.06E-01	1.58E-01	0.09665 *	0.14274	1.14E-01	1.57E-01	0.1738	0.1501
good health	6.35E-02	9.31E-02			-6.50E-02	9.48E-02		
other chronic illness	-1.17E-01	8.47E-02			-2.31E-01 **	8.62E-02		
active smoker	5.51E-02	7.54E-02			-6.40E-03	7.56E-02		
regular attacks	4.59E-01 ***	8.67E-02			1.26E-02	8.04E-02		
regular medication	2.43E-01 **	7.62E-02			1.59E-01 *	7.87E-02		
reference income	6.78E-06	1.11E-05			5.01E-06	1.22E-05		
age	2.24E-03	3.02E-03			-4.19E-03	3.16E-03		
male	7.32E-02	7.14E-02			1.30E-01	7.27E-02		
married	-9.93E-02	7.81E-02			-1.17E-01	7.88E-02		
college	1.06E-01	8.92E-02			2.05E-02	9.27E-02		
household size	2.11E-02	2.93E-02			9.91E-03	2.81E-02		
log(scale)					-1.26E-02	2.55E-02	0.0107	0.0229
N	1437		1837				1203	
Pr[WTP>0]	0.58		0.59					
Log-likelihood	-909.77		-1206.99					

Notes: no. of observations in full model is lower than in simple model due to missing data on explanatory variables (mostly on income)
Signif. codes: *** 0.001, ** 0.01, * 0.05

The model confirms that country variables are significant predictors both in the participation part of the model as well as in size of WTP. Taking the Czechs as a baseline, Greeks (and Norwegians and Slovaks in the simple 'countries only' model) are statistically significantly more prone to participation while Germans and particularly Brits are less likely to express non-zero WTP. In the model of positive WTP, Germans, Greeks and Norwegians express significantly higher WTP, while Brits express lower WTP (but significant only in simple 'countries only' model). Overall, we observe minimum differences between regression models on interval data and on open-ended data.

We found the two variables related to asthma frequency and medication to be significant predictor of participation, but only the latter is significant predictor of positive WTP (and only in interval data regression). Furthermore, presence of other chronic illness is a positively associated with WTP in both interval and open-ended data. We find no statistical significant influence of income what is somewhat difficult to explain as underlying economic theory suggests that income should be positively associated with WTP.

Table 8 - Regression models of open-ended WTP

	Model 1 - participation (probit)				**Model 2 – positive WTP (lognormal – positive)**			
	full model		**simple model**		**full model**		**simple model**	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
constant	-1.30E-01	1.82E-01	0.276 ***	0.063	3.83E+00 ***	3.83E+00	3.574 ***	0.069
German	-2.91E-01 *	1.46E-01	-0.242 *	0.121	7.07E-01 ***	7.07E-01	0.646 ***	0.143
British	-5.15E-01 ***	1.02E-01	-0.463 ***	0.083	-1.90E-01	-1.90E-01	-0.175 .	0.100
French	2.08E-01	1.47E-01	0.321 *	0.126	3.17E-01 *	3.17E-01	0.198	0.125
Greek	4.50E-01 *	1.76E-01	0.527 ***	0.140	7.19E-01 ***	7.19E-01	0.736 ***	0.128
Norwegian	8.87E-02	1.40E-01	0.083	0.102	9.56E-01 ***	9.56E-01	0.874 ***	0.110
Slovak	9.04E-02	1.62E-01	0.135	0.147	1.51E-01	1.51E-01	0.204	0.155
good health	7.43E-02	9.64E-02			-5.96E-02	-5.96E-02		
other chronic illness	-1.17E-01	8.78E-02			-2.79E-01 **	-2.79E-01		
active smoker	6.49E-02	7.81E-02			-2.51E-02	-2.51E-02		
regular attacks	4.48E-01 ***	9.00E-02			6.34E-03	6.34E-03		
regular medication	2.27E-01 **	7.87E-02			1.13E-01	1.13E-01		
reference income	6.13E-06	1.11E-05			1.59E-07	1.59E-07		
age	2.14E-03	3.13E-03			-3.75E-03	-3.75E-03		
male	7.22E-02	7.44E-02			1.19E-01	1.19E-01		
married	-7.70E-02	8.07E-02			-1.41E-01	-1.41E-01		
college	1.24E-01	9.35E-02			-4.73E-03	-4.73E-03		
household size	2.94E-02	3.03E-02			-1.27E-02	-1.27E-02		
log(scale)					1.06E+00 ***	1.06E+00	1.089 ***	0.0245
N	1344	1714						
Pr[WTP>0]	0.585		0.575					
Log-likelihood	-5045.1		-6380.1					

Notes: no. of observations in full model is lower than in simple model due to missing data on explanatory variables (mostly on income)
Signif. codes: *** 0.001, ** 0.01, * 0.05

Discussion

The endpoint used in our study is to some extent different from those used in previous studies that were mostly looking for WTP to avoid a single day with asthma symptoms. In Brandt et al. (2012) study estimated a mean WTP for avoiding single day with symptoms at USD 9.75 to 11.39 (EUR_{2010} 7.7 to 9) and at USD 20.4 to 23.82 (EUR_{2010} 16.1 to 18.8) for avoiding a day with bad symptoms. A previous study by Rowe and Chestnut (1984) gives an estimated WTP for avoiding a single day of bad asthma symptoms of USD_{1983} 22 (EUR_{2010} 17.4), what is well in line with Brandt et al. study, while another study by O'Conor and Blomquist (1997) reports a WTP of USD 67-89 (EUR_{2010} 53-70) per bad symptom day avoided and USD 36-47 (EUR_{2010} 28.5-37) per day of symptom day avoided. Our WTP estimate is at upper range of these estimates, but this may be a reflection of that asthma exacerbation may take longer than one day. We also note that in US EPA's benefit-cost analyses asthma exacerbations are valued at USD 50 per incidence (1990 income level, i.e. about EUR_{2010} 63), based on the mean of average WTP estimates for the four severity definitions of a "bad asthma day," described in Rowe and Chestnut study.

Benefit transfer

As the final step we derive EU-wide WTP values by means of benefit transfer of estimated WTP values. Hence, we use WTP estimates from non-parametric and parametric interval and open-ended data and purchasing power adjusted income data from Eurostat (median equivalized household incomes). We tried to estimate income elasticity of WTP from pooled data but the estimated coefficient is extremely small and not statistically significant. We run separate regressions for individual countries to find that the income coefficient is not significant in all but one country. The estimated income elasticity of WTP in the Czech Republic is about 0.278. This estimate is in the range of income elasticities estimated in the survey on WTP to avoid skin sensitisation and dose toxicity, so we use it here for benefit transfer.

Table 9 - Mean EU28-wide WTP for avoiding asthma discomfort (in EUR)

	interval non-parametric	interval parametric	open-ended non-parametric	open-ended parametric
weighted	47.0	53.5	47.5	52.4
unweighted	45.4	51.7	45.9	50.7

The mean weighted EU-wide WTP is about EUR 47 from non-parametric estimates and about EUR 53 from parametric estimates. Considering the small difference between these estimates we suggest using **EUR 50 as a central EU-wide value of asthma episode discomfort**.

Willingness to pay for avoiding acute respiratory sensitisation

As a follow up to HEIMTSA valuation survey on respiratory health effects[6], an episode of respiratory sensitisation was evaluated using CV method in the Czech Republic, Slovakia and the United Kingdom.

Respiratory sensitisation was used as an alternating health outcome to cough-day (the other endpoints valued were the same as in main HEIMTSA valuation study, i.e. 3 severity levels of COPD and asthma discomfort in asthmatics). The data related to valuation of respiratory sensitisation are analysed as a part of this study for ECHA.

The description of respiratory sensitisation used a profile of an acute hypersensitivity pneumonitis episode (IDC 10: J67). Hypersensitivity pneumonitis (also called extrinsic allergic alveolitis) is an inflammation of the lungs due to breathing in a foreign substance, often organic dusts, moulds, fungus, and chemicals such as isocyanates or acid anhydrites. The narrative description of acute respiratory sensitisation by its symptoms, frequency, duration, consequences and outlook used in the survey was the following:

Table 10 – Description of respiratory sensitisation episode

Symptoms	Fever, chills, cough, chest tightness, headaches and fatigue lasting for 1 day
Frequency	All day long
Duration	For one day
Consequences	Normal quality of life
Outlook	Return to normal health

To our knowledge no valuation study on acute respiratory sensitisation has been conducted so far. Our presupposition was that the willingness-to-pay for avoiding respiratory sensitisation would be comparable to that of 'cough-day' endpoint or 'stomach-day' endpoint from 5-country study (Ready et al., 2004).[7]

Questionnaire and survey

The contingent valuation scenario of respiratory sensitisation episode was the first one CV scenario presented to respondents to the survey and alternated with cough-day (i.e. one half of the respondents was randomly assigned respiratory sensitization CV scenario while the other half cough-day CV scenario). The survey had a conventional structure, consisting of 6 parts, starting with introduction of health outcomes, following with their rating, contingent valuation, chained standard gambles, concluding with questions on socio-economic characteristics, perceptions and behaviour of the respondent.

The mode of delivery of valued good (i.e. avoidance of illness) was an unspecified instant cure (i.e. private good) and the WTP was elicited as a single (lump-sum) payment. The elicitation method used was multiple-bounded dichotomous choice, therefore WTP intervals were obtained (i.e. interval

[6] Deliverable 4.1.3 – Presentation of unit values for health-endpoints: country-specified and pooled, available from: http://www.heimtsa.eu/language/en-GB/Results/Deliverables.aspx

[7] WTP for avoiding cough-day was estimated at GBP_{1998} 27.3 and WTP for avoiding stomach-day was estimated at GBP_{1998} 35.5 in the said study. In HEIMTSA, WTP for avoiding cough-day was estimated at EUR_{2010} 35.

between highest bid accepted and lowest bid rejected, or unbounded interval from right if all the bids were accepted).
Each respondent was randomly assigned one of five predefined starting bids (EUR 10, 20, 50, 100, 150) and subsequent bids were increased or decreased along predefined paths. The bids came from the interval between 1 and 200 euros. The bids were adjusted according to parity level (using latest Eurostat HICP data) of the respective country.
The survey was conducted in December 2012 on a total sample of 5,548 respondents, and the number of respondents in subsample with respiratory sensitisation was 2761.

Descriptive statistics

In the following table descriptive statistics of respiratory sensitization subsample are summarized and compared to population statistics. The comparison shows that our sample has consistently large household sizes in all three countries, tertiary education is overrepresented in Slovakia and the UK, and underrepresented in Czech Republic and equivalized net income of our UK sample is higher than in the population.

Table 11 - Descriptive sample and population statistics

	Czech R.	Slovakia	UK
male proportion - sample	51.5%	47.3%	50.9%
male proportion - population	49%	49%	49%
age (mean) - sample	40.6	38.1	42.8
age (mean) - population	40.6	38.6	39.5
average household size - sample	3.1	3.4	2.9
average household size - population	2.4	2.8	2.3
tertiary educated - sample	14%	24%	39%
tertiary educated - population	17%	17%	34.7%
equivalised mean net household income (€) – sample	10,540	10,789	26,829
equivalised mean net household income (€) – population	11,455	10,442	21,053
sample size	919	914	923

Note: Population data are from EUROSTAT, referring to 2012 (except for household size)

Willingness to pay estimation

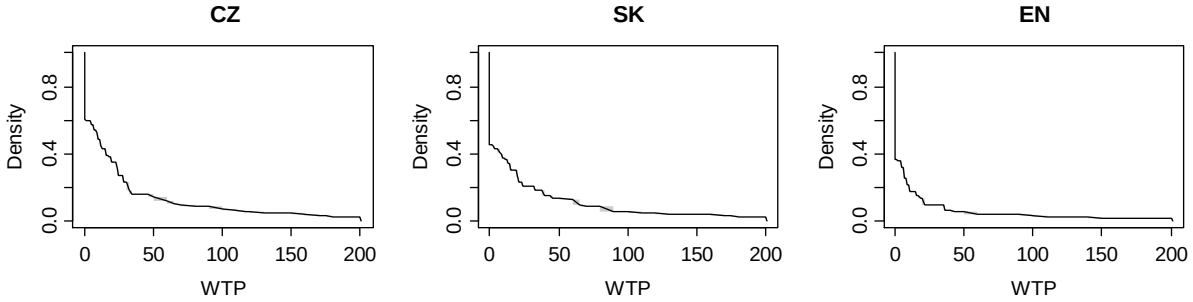
In the questionnaire WTP elicitation was preceded by question on "participation" in contingent market, i.e. whether the respondent would consider paying for avoiding the illness. We encountered here a considerable share of respondents who did not want to pay anything, 63% in the UK, 54% in Slovakia and 40% in the Czech Republic (a similar situation were encountered also in the subsample with cough-day as the first valued illness). We disentangled these responses using a debriefing question into 'true zeros' if the reason was that the outcome is not perceived worth of paying to avoid it or that the respondent cannot afford to pay for it and 'protest zeros' if the respondent claimed that national health service should pay or perceived the treatment as untrustworthy. We identified 593

respondents in total as protesting to the CV scenario and these respondents were not included in the analysis.

We use two approaches to estimate WTP – non-parametric and parametric modelling. The first approach has the advantage of distribution-free WTP estimation, but allows only for limited inclusion of covariates. For the parametric modelling we use the two-part model that is well equipped to deal with large proportion of zero answers ('non-participation') – in our case about half of the respondents stated that they won't consider paying for avoiding such illness.

The empirical distribution of WTP from non-parametric Kaplan-Meier (Turnbull) estimation is depicted in Figure 1.

Figure 1 – Kaplan-Meier survivor functions of WTP from interval data



The graphs succinctly illustrate the 'non-participation' in contingent market as vertical lines in the upper left part of the graphs – this share differs significantly among the countries from less than 40% in the Czech Republic to almost 64% in the UK . The willingness to pay is estimated from a cumulative sum of probabilities of ordered statistics of innermost intervals derived from individual observations.

The two-part parametric modelling splits WTP estimation into two steps – in the first step participation in CV elicitation is estimated as a discrete choice using probit model, in the second step interval regression for positive values is estimated[8] and results are subsequently weighted by participation probability. Table 12 summarizes WTP estimates from both approaches, non-parametric and two-part parametric.

Table 12 – mean WTP for avoiding respiratory sensitisation episode (in EUR)

	no. of obs.	**non-parametric**		**two-part parametric**	
		mean	median	mean	median
CZ	708	24.4	9	21.5	13.5
SK	677	20.5	(0)	18.0	10.6
EN	783	10.7	(0)	8.9	5.1
pooled	2168	18.3	(0)	15.9	9.5

The estimated mean WTP values are EUR 18.3 from non-parametric and EUR 15.9 from two-part model using the pooled data. The highest WTP was elicited among Czech respondents, and the lowest among UK respondents. In spite the substantial influence of the participation rate (59% vs. 36%), UK respondents have also the lowest WTPs in the positive part of the two-part model (but Slovaks have slightly highest than Czechs).

[8] Lognormal distribution fitted reasonably well the data with right-skewed distribution.

Validity test

We run several two-part models to explore the effect of variables conventionally deemed to be correlated to willingness to pay, such as income or education. We report two models, the first one with larger set of covariates, the second one with country dummies only (CZ as contrast); we use the same covariates in both parts of the two part model. The model confirms that country variables are significant predictors in the participation part of the model (both UK and SK variables are negative), and UK variable is also negative and significant variable in second part of the model. We also find that income (either individual or household specified by the respondent as the one s/he took into account) is significant and positive predictor in the second part of the model, in line with our expectation. We also find that age and living single is positively associated with probability of participation in WTP elicitation.

Table 13 – Regression models of WTP

Model 1 – all covariates			
Part 1 – participation (probit)			
	Estimate		Std. Error
Constant	1.01E-01		1.49E-01
Slovak	-3.37E-01	***	7.39E-02
UK	-5.96E-01	***	7.83E-02
single	3.10E-01	*	1.42E-01
college	7.65E-02		7.19E-02
income	2.23E-06		7.81E-06
gender (male)	-9.89E-02		6.08E-02
age	5.47E-03	*	2.35E-03
chronic respiratory illness	1.71E-01	*	6.81E-02
log likelihood	-1191.757		
Part 2 – interval WTP (log-normal)			
	Value		Std. Error
Constant	3.26E+00	***	1.77E-01
Slovak	1.69E-02		8.40E-02
UK	-4.77E-01	***	9.26E-02
single	-1.89E-01		1.42E-01
college	9.98E-02		8.43E-02
income	2.07E-05	*	1.05E-05
gender (male)	-2.49E-02		7.02E-02
age	-3.85E-03		2.85E-03
chronic respiratory illness	5.04E-02		7.59E-02
Log(scale)	-1.65E-02		2.53E-02
log likelihood	-2093.3		
N=822			

Model 2 – country dummies only			
Part 1 – participation (probit)			
	Estimate		Std. Error
Constant	0.2614	***	0.04769
Slovak	-0.37084	***	0.06786
UK	-0.59565	***	0.06606
log likelihood	-1457.856		
participation	0.456	(median)	
	0.473	(mean)	
Part 2 – interval WTP (log-normal)			
	Value		Std. Error
Constant	3.12152	***	0.0494
Slovak	0.0506		0.0766
UK	-0.48376	***	0.0777
Log(scale)	-0.00769		0.0231
log likelihood	-2512.6		
N=984			

Note: Signif. codes: *** 0.001, ** 0.01, * 0.05

Discussion

Although the direct comparison of our results with previous studies is not possible we can compare the WTP estimates with those for avoiding cough-day outcome alternating with respiratory sensitisation in the questionnaire. Also in this case we encountered considerably high share of true-zeros, 59% in pooled sample (on per country basis it was 47% in the Czech Republic, 58% in Slovakia and 70% in the UK). The mean WTPs estimated from non-parametric models are somewhat higher: EUR 18.9

(pooled), EUR 25.5 (Czech R.), EUR 20.5 (Slovakia), and EUR 10.8 (UK). We also compared the differences between the two subsamples using Mann-Whitney U test to find that the two distributions are not equal (Z=3.2, p=0.001).

Benefit transfer

In order to derive EU-wide values we use benefit transfer with mean WTP values from non-parametric and two-part parametric model (and cross-validate the results using country estimates) and income data for EU28 from Eurostat database (median equivalized household incomes). We run into difficulty in deriving respective income elasticity of WTP because for pooled data the estimated income elasticity is not statistically significant (at the conventional 0.05 significance level). We therefore use WTP income elasticity of 0.24 (gross impact of income) that was estimated from pooled Czech and Slovak subsamples (what also seems to be comparable to WTP income elasticities estimated for skin sensitisation – see the main report).

Table 14 – Mean EU28-wide WTP for avoiding respiratory sensitisation (in EUR)

	non-parametric	**parametric**
weighted	18.6	16.1
unweighted	18.0	15.7

The mean weighted EU-wide WTP is either EUR 18.6 (based on non-parametric model of WTP) or EUR 16.1 (based on two-part parametric model). We therefore suggest using **EUR 17.5 as a central EU-wide WTP value** for avoiding respiratory sensitisation.

References

Blomquist, G. C., Dickie, M., & O'Conor, R. M. (2011). Willingness to pay for improving fatality risks and asthma symptoms: Values for children and adults of all ages. *Resource and Energy Economics*, *33*(2), 410–425. doi:10.1016/j.reseneeco.2010.05.004

Blumenschein, K., & Johannesson, M. (1998). Relationship between quality of life instruments, health state utilities, and willingness to pay in patients with asthma. *Annals of Allergy, Asthma & Immunology : Official Publication of the American College of Allergy, Asthma, & Immunology*, *80*(2), 189–94. doi:10.1016/S1081-1206(10)62954-7

Brandt, S., Vásquez Lavín, F., & Hanemann, M. (2012). Contingent valuation scenarios for chronic illnesses: the case of childhood asthma. *Value in Health : The Journal of the International Society for Pharmacoeconomics and Outcomes Research*, *15*(8), 1077–83. doi:10.1016/j.jval.2012.07.006

Kim, C.-Y., Park, H.-W., Ko, S.-K., Chang, S.-I., Moon, H.-B., Kim, Y.-Y., & Cho, S.-H. (2011). The financial burden of asthma: a nationwide comprehensive survey conducted in the republic of Korea. *Allergy, Asthma & Immunology Research*, *3*(1), 34–8. doi:10.4168/aair.2011.3.1.34

Lötvall, J., Ekerljung, L., Rönmark, E. P., Wennergren, G., Lindén, A., Rönmark, E., … Lundbäck, B. (2009). West Sweden Asthma Study: prevalence trends over the last 18 years argues no recent increase in asthma. *Respiratory Research*, *10*(1), 94. doi:10.1186/1465-9921-10-94

O'Conor, R. M., & Blomquist, G. C. (1997). Measurement of consumer-patient preferences using a hybrid contingent valuation method. *Journal of Health Economics*, *16*(6), 667–83. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10176778

Ready, R., Navrud, S., Day, B., Dubourg, R., Machado, F., Mourato, S., … Rodriquez, M. X. V. (2004). Benefit transfer in Europe: How reliable are transfers between countries? *Environmental and Resource Economics*, *29*(1), 67–82. doi:10.1023/B:EARE.0000035441.37039.8a

Rowe, R. D., & Chestnut, L. G. (1984). *Valuing changes in morbidity: WTP versus COI measure*. Boulder. Retrieved from http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0262.pdf/$file/EE-0262.pdf

Zillich, A. J., Blumenschein, K., Johannesson, M., & Freeman, P. (2002). Assessment of the Relationship Between Measures of Disease Severity, Quality of Life, and Willingness to Pay in Asthma. *PharmacoEconomics*, *20*(4), 257–265. doi:10.2165/00019053-200220040-00004