Project no. 6529

VERHI
(www.oecd.org/env/social/envhealth/verhi)

Valuation of Environment-Related Health Impacts: Accounting for Differences across Age and Latency with a Particular Focus on Children

Instrument: Specific Targeted Research Project

Thematic Priority: 8.1.B.2.3

Final Publishable Activity Report

Period covered: from 1 January 2006 to 30 June 2009

Date of preparation: September 2009

Start date of project: 1 January 2006

Duration: 2006-2009
(42 months)

Project coordinator name: Nick Johnstone
Project coordinator organisation name: Organisation for Economic Co-operation and Development

1 Part 1: Project Execution

1.1 General Overview of the VERHI Project

1.1.1 Objectives of the Project

The small number of economic valuation studies estimating the benefits of pollution-control policies for children's health provides little guidance for environmental policy-making. Indeed, existing values used for monetisation of environmental health impacts focus on adult populations, applying scenarios that often do not match well with environmental settings. As such, there is a concern that the continued use of such estimates may result in misguided policy-making and prioritisation.

The objective of this project is therefore to improve the incorporation of environment-related health impacts for children in environmental policy-making. In addition to methodological contributions to the valuation of environment-related health impacts for children, the work undertaken in the context of the VERHI project is anticipated to contribute to the development of regulatory standards, to policy development, and to risk assessment and communication strategy. At least three impacts on the EU research and policy agenda are anticipated:

- estimation of values which are specific for children;
- the ratio of values obtained for children and adults (e.g. MRS); and,
- evaluation of alternative methodologies for addressing such factors and populations.

Estimation of values specific to children

It is reasonable to think that differences between estimated VSL for adult and child populations are attributable in part to differences in age. However, age differences do not capture all of the potential sources for differences in VSL between adult and child populations. The distinctive role of children within the household, the relative importance of paternal altruism, and other factors (i.e. degree of voluntariness of exposure or perceptions of dread) may well affect VSL for children relative to adults in a manner which is distinct from simple differences in age. Unfortunately, there is a paucity of research in this area. This leaves little guidance for policy makers on how to value health risks to children. Due to the lack of empirical research on VSL, most economic analyses rely on adult VSL estimates for children's health effects. The research has contributed to filling this gap by obtaining values specifically for children.

Ratio of values for children and adults

While there is likely to be a significant degree of uncertainty associated with any specific values obtained (whether for adults or children), the ratio of values obtained from a study in which the VSLs estimated for both adults and children are directly comparable can assist policymakers in their evaluation of policies which affect both populations. In principle, the 'marginal rate of substitution' (MRS) between the estimated VSL for a child and for an adult can be used to adjust estimated benefits for policy and programmes should the MRS not equal one. However, clearly more research is required, and the results of VERHI represent a contribution to this literature.

Contribution to methodological development

The values obtained are, of course, important outcomes from the project. However, there are important and contentious methodological issues which need to be addressed when valuing environmental health impacts differentiated according to risk and individual characteristics. As such, through the preparation of the methodological reviews, the very extensive survey development work, as well as the empirical work itself, it is anticipated that the project will also make a more general contribution to developments in the "state-of-the-art" in this area. Thus, by providing guidance on how to undertake such studies in the future, the outcomes of the project will be of broader relevance to the research and policy communities.

1.1.2 The VERHI Consortium and Project Structure

The consortium members are presented below. In addition, to researchers at each of the institutes listed, the project benefited from leading researchers in the field, including Prof. Ståle Navrud, Dr. Alistair Hunt, Prof. James Hammitt.

The Consortium Members

Organisation	Acronym	Country	Participants	Tasks/Expertise
Environment Directorate, Organisation for Economic Co-operation and Development http://www.oecd.org/env/social/envhealth/verhi	OECD	International	Nick Johnstone, Pascale Scapecchi	Policy analysis, research dissemination, co-ordination and management
Sustainability Indicators and Economic Valuation Program, Fondazione Eni Enrico Mattei http://www.feem.it/Feem/default.htm	FEEM	Italy	Anna Alberini, Aline Chiabi, Stefania Tonin, Marcella Veronesi	Survey development (CCE), survey implementation, data analysis
Centre for Social and Economic Research on the Global Environment, University of East Anglia http://www.uea.ac.uk/env/cserge/	UEA	United Kingdom	Ian Bateman, Silivia Ferrini, Katie Bolt, Graham Loomes, Brett Day	Survey development (Chaining), survey implementation, data analysis
Environmental Economics Unit, Charles University Environment Center http://cozp.cuni.cz/COZPENG-5.html	CUEC	Czech Republic	Milan Ščasný, Marketa Braun Kohlová, Hana Škopková Jan Melichar	Surve development, survey implementation, data analysis, benefits transfer

The project was overseen by an Advisory Group, including leading academics, government officials, and representatives of international organisations. The composition of the Advisory Group is presented below.

Composition of the Advisory Group

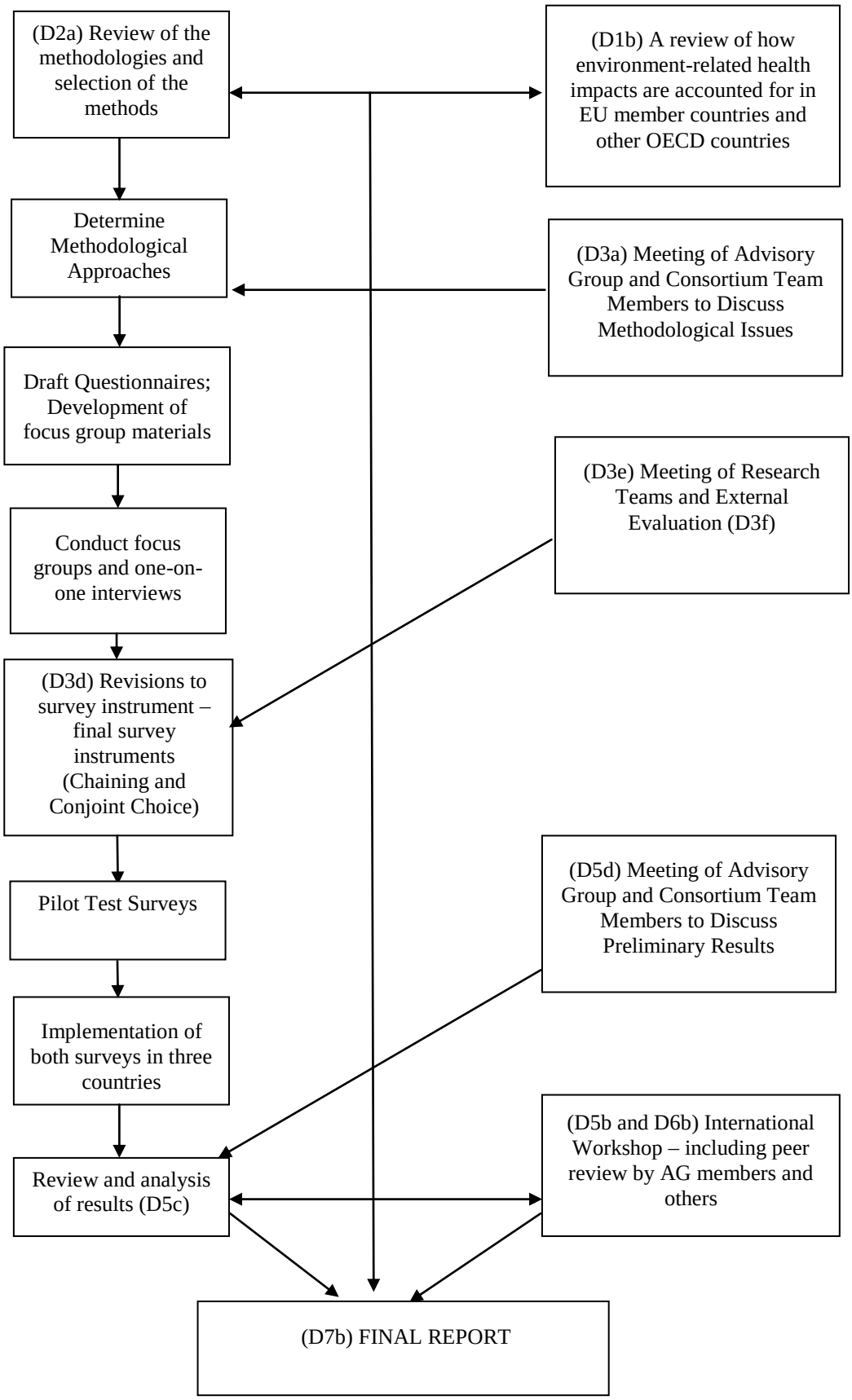
	Name	Position
Academics	Prof. Per-Olov Johansson	Professor, Department of Economics, Stockholm School of Economics
	Prof. Michael Jones-Lee	Professor, The Business School, University of Newcastle
	Prof. Mark Dickie	Associate Professor of Economics, University of Central Florida
	Prof. Richard Carson	Professor, Department of Economics, University of California at San Diego
Government Officials	Mr. Bob Davies	Senior Economic Adviser, UK Department of the Environment, Food and Rural Affairs
	Mr. Ed Chu	Office of Solid Waste and Emergency Response, US Environmental Protection Agency
	Mr. Aldo Ravazzi	Italian Ministry of the Environment
	Dr. Eva Rychlikova	National Institute of Public Health of the Czech Republic
	Ms. Lena Nemer	Technical Officer, WHO European Centre for Environment and Health, Rome
Others	Mr. Stephen White	European Commission, DG Environment
	Mr. John Bell	European Commission, DG SANCO

The structure of the project was affected by the outcome of survey development work which indicated that it would be more fruitful to implement two distinct survey instruments, with the the CUEC team in the Czech Republic implementing both instruments in order to ensure comparability of results.

Methods Implemented in the Three Countries

	CR	IT	UK
Contingent Valuation	Yes (morbidity)	Yes (mortality)	Yes (morbidity)
Conjoint Choice Experiment	Yes	Yes	No
Standard-Gamble (Chaining)	Yes	No	Yes
Person Trade-Off	Yes	No	No

Project Structure



1.1.3 Overview of the work performed and results obtained

Policy Review (WP2)

Preparation by the OECD Secretariat of a review of policy evaluation and valuation practices in OECD countries, both in the environment and health fields. The report also includes a review of current environmental legislation to determine whether children's specific vulnerability to environmental hazards is correctly taken into account.

The policy review suggested that (1) economic evaluation tools, such as cost-benefit analysis, cost-effectiveness analysis and cost-utility analysis, are rarely and unevenly used across OECD countries; and (2) current environmental legislation does not target children, which may suggest that children may not be adequately protected from environmental hazards.

Main deliverable:

Use of Evaluation Tools in Policy-making and Health Implications for Children by Pascale Scapecchi *(D1a)*

Methodological Reviews (WP3)

Preparation of three methodological reviews by external consultants to provide insights on three methodological issues associated with the valuation of children's health: identification of the most appropriate valuation framework (WTP or QALY frameworks); review of revealed-preferences (RP) and stated-preferences (SP) studies undertaken in this area to assess their relative strengths and weaknesses; and, review of the epidemiological literature to identify a credible environmental health risk for both adults and children.

The methodological review on WTP and QALY approaches suggested that the WTP framework was more appropriate for this project than the alternative framework. In addition, the review of revealed preference and stated preference studies highlighted the scarcity of studies and estimates in this area. While it would be preferable to combine both approaches, in practice with the number of issues to be addressed in the project this did not appear to be practicable. It was decided that stated preference was more appropriate. Finally, the review of the epidemiological literature revealed the emphasis of research on the linkages between air pollution and mortality risks to children, as well as the limited evidence relative to other types of environmental degradation that could affect children (and adults as well).

Main deliverables:

Methodological Review of WTP and QALY Frameworks for Valuing Environmental Health Risks to Children by Jim Hammitt *(D1b)*

Review and Summary of the Epidemiological Literature on Children's Health Risks Associated with Environmental Exposures by Alistair Hunt *(D1b)*

Review of Revealed Preferences Studies for Children's Environmental Health by Alistair Hunt *(D1b)*

Survey Design (WP4)

In order to design the survey instruments and implementation plan, a very large number of one-on-one interviews, focus group discussions and pilot studies were implemented. This led to the decision to not implement some methods which had been initially foreseen (e.g. City A vs. City B) or to do so in a restricted manner (e.g. Person Trade-off). Refinements to the methods selected as most promising ('chaining' and conjoint choice experiments) were developed and tested extensively. In addition, complementary questions associated with elicitation of respondents' awareness of environmental concerns and understanding of notions of probability and risk were tested. And finally, alternative methods of communicating risk were assessed.

Survey Development Work Undertaken

Date	Location	Sample	Type
January 2006	Norwich (UK)	99 UEA students	Experiment design
July 2006	Cambridge (UK)	25 parents	Pilot study
August-September 2006	Cambridge (UK)	300 parents with at least a child aged 13 or under	Pilot study
September 2006	Milan and Mestre (Italy)	16 parents in each city with at least one child aged 0-12 (8 respondents each)	Focus group discussions
October 2006	Roma (Italy)	14 parents with at least one child aged 0-12	Focus group discussions
October 2006	Prague (Czech Republic)	15 parents of children aged 0-14	Focus group discussions and individual interviews.
December 2006	Venice (Italy)	15 parents	Focus group discussions
January 2007	Venice, Vittorio Veneto and Garda (Italy)	13 parents with children aged 0-14	One-on-one interviews
January 2007	Prague (Czech Republic)	18 parents with child aged 0-14	One-on-one interviews
May 2007	Prague (Czech Republic)	14 parents with child aged 0-14	One-on-one interviews

Date	Location	Sample	Type
October 2007	Norwich (UK)	10 parents	One-on-one interviews
November – December 2007	Norwich (UK)	13 parents	One-on-one interviews
March 2008	Prague (Czech Republic)	9 parents with child aged 0-17	One-on-one interviews
March 2008	Prague (Czech Republic)	9 parents	One-on-one interviews
May 2008	Colchester (UK)	30 parents	Pilot study
June 2008	Milan (Italy)	7 parents	Pilot study
July 2008	Prague	9 parents	One-on-one
August 2008	Prague	106 parents	Pilot
Sept-October	Prague	323 parent	Pilot

On the basis of the findings from this work two 'complementary' survey instruments were developed and applied on a pairwise basis in the three countries. In total, four different methods were applied, all of which had been tested extensively: contingent valuation; conjoint choice experiments, standard gamble, and person trade-offs. However, not all methods were applied in all countries, and some of the methods are linked (see Table below.)

Methods Implemented in the Three Countries

	CR	**IT**	**UK**
Contingent Valuation	Yes (morbidity)	Yes (mortality)	Yes (morbidity)
Conjoint Choice Experiment	Yes	Yes	No
Standard-Gamble (Chaining)	Yes	No	Yes
Person Trade-Off	Yes	No	No

A summary of the focus group discussions and the survey instruments are provided as deliverables.

Main deliverables:

Summary of Focus Group Materials and Discussions (D3b)

Questionnaire for Chaining Exercise (D3d)

Questionnaire for Conjoint Choice Experiment (D3d)

Implementation of the Survey (WP5)

The surveys were implemented in mid-2008 and late-2008 with target samples of approximately 1,000 parents per country per instrument, generating a total of 5,412 observations. The surveys used several methods, thus allowing for the derivation of more than one VSL value for adults and children, or the MRS between children and adults.

For the CV/chaining exercise, the United Kingdom implemented surveys in 14 locations over 31 days. The means of implementation was face-to-face interviews, with personal interviewers providing assistance with respect to the manipulation and comprehension of various physical devices (e.g. payment cards), with responses input directly into laptop computers. A similar exercise was implemented in the Czech Republic for the chaining exercise with interviews taking place in six regions, including Prague, Ostrava and Brno. In addition, the interviews were conducted at the respondents' home.

For the conjoint choice experiments, the means of implementation was through self-administered personal interviews, which allows for the random assignment of treatments (essential for conjoint choice experiments). In Italy, the survey was implemented in Milan (a city in which air pollution is a concern) amongst a sample of 1906 respondents, while in the Czech Republic the spatial distribution of the sample was the same as had been the case for the chaining exercise and the sample size is 1506. In addition, in Italy respondents were recruited and brought to a central location (similar to the UK), while in the Czech Republic it took place in people's homes.

The CV/chaining surveys were implemented in mid-2008 (United Kingdom) and late-2008 (Czech Republic and Italy). As noted above, for the chaining exercise, two surveys with the same questionnaire format have been conducted in the UK and the Czech Republic. Professional survey companies were responsible for data collection and data cleaning. In the UK a nationally representative sample was collected.

In the Czech Republic, the survey was implemented Prague and Brno, as well as six provinces. This involved quota sampling of parents with at least one child below 18 years of age (that doesn't necessarily have to live in respondent's household). Quotas were also used for respondent age (18-34, 35-44, 45+), gender, level of education (three levels), regions (six), and size of municipality *(cities, 50k-100k, 10k-50k, 2k-10k, 2k less).* The interview mode was via computer-administered personal interviews in the home.

Respondent Characteristics for Chaining Exercise

	UK			CZECH REP		
	Min	Max	Mean (st.dev.)	Min	Max	Mean (st.dev.)
Household members	2	11	3.66 (1.23)	1	7	3.46 (0.91)
Age of parent	21	57	37 (9.24)	18	65	39.5 (10.23)
Age of child	0	17	8 (5.55)	1	17	9.8 (5.35)
Number of children in household	1	9	1.75 (.98)	1	8	1.66 (.87)
Income, in £	3,000	100,000	27,758 (22,600)	1,967	25,574	12,516 (4,761)
in £ PPP-adjusted	4,601	153,374	42573 (34,663)	3,026	39,344	19256 (7,324)

In the UK, in order to collect an approximately representative sample of parents, 14 UK locations were selected. Thirty-one days of face-to-face interviewing took place, including some weekends to ensure inclusion of working people. The interviews took place at central locations and interviewers were trained to deal with emotive topic such as child safety and to minimise the well documented interviewers' bias.

For the second survey instrument, the approach also involved quota sampling. However, in the case of Italy, only residents of Milan (where air pollution is a problem) were sampled. Respondents were between the ages of 20 and 60, and only parents were included in the sample. The maximum age of the child age was 17. The sample was evenly split between mothers and fathers, but homemakers were restricted to no more than 20% of the women in the sample. In addition equal quotas for three age categories (30-34; 35-44; and 45-49) were applied. Quotas were also applied for education and relative wealth. The means of implementation was through a self-administered computer questionnaire.

The Czech sample followed the same quotas as for the Milan sample, but was representative of the Czech population, including major cities (Prague, Ostrava and Brno), as well as smaller towns and rural areas. Interviewers were sent to people's homes, where they conducted the survey in-person using the computer in a manner similar to that used in Italy, *i.e.*, self-administered by the respondent.

Respondent characteristics for Conjoint Choice Experiment

a. Discrete Variables

	ITALY		CZECH REP.	
variable	N valid	percentage of the sample	N valid	percentage of the sample
Male	1906	49.06	1505	46.91
age: younger than 35	1901	33.56	1506	38.11
age: 35 to 44	1901	32.93	1506	22.58
age: older than 45	1901	33.51	1506	39.31
elementary school diploma	1906	0.21	1506	3.05
high school	1906	30.59	1506	35.79
high school diploma	1906	43.23	1506	46.81
college degree	1906	24.29	1506	11.75
graduate work (PhD)	1906	1.57	1506	2.59
homemaker	1906	7.29	1506	1.73
household income above 30,000 euro	1891	43.68	1317	26.35

b. Continuous Variables.

	ITALY					CZECH				
	N	mean	s.d.	Min	Max	N	mean	s.d.	Min	Max
Age	1906	**39.70**	*9.99*	20	59	1500	**39.61**	*10.59*	18	65
income (Euros)*	1891	**30463**	*12120*	5000	87500	1317	**23606**	*9574*	3529	50471
hhold size	1906	**3.21**	0.698	1	8	1503	**3.50**	0.920	1	9
children	1906	**1.31**	*0.549*	1	5	1506	**1.56**	*0.688*	1	5
agemax	1905	**9.33**	*7.491*	1	35	1486	**11.84**	*7.792*	0	45
agemin	1905	**7.67**	*6.020*	1	31	1486	**8.53**	*5.981*	0	24

* Income in Czech crown was recalculated by purchasing power parity assuming 17 CZK per Euro. Mean net annual income in national currency amounts 401,310 CEK (s.d.=162,757 CZK) with minimum of 60,000 CZK and maximum of 858,000 CZK..

Main deliverables:

Complete dataset based on Conjoint Choice Experiment in Italy and Czech Republic (D4b)

Complete dataset based on Chaining Exercise in the United Kingdom and Czech Republic (D4b)

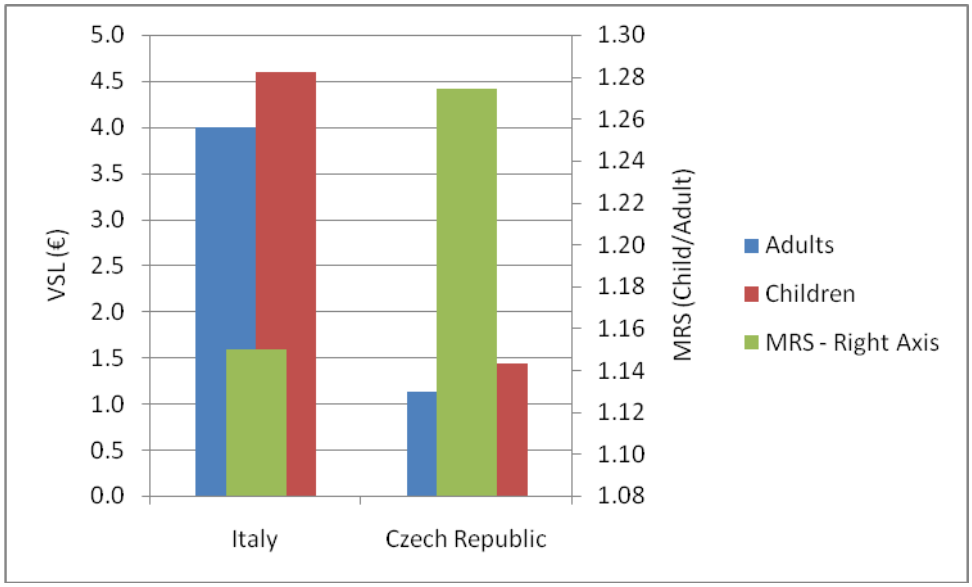
Data Analysis (WP6)

Data analysis took place from Q4 2008 onward. Initial (and very preliminary) results were presented at a meeting of the Advisory Group and Research teams held on December 12th 2008 in Paris. On the basis of insights gained from this meeting, further analysis was undertaken and a number of papers were presented at the meeting of the European Association of Environmental and Resource Economists (Amsterdam, June 2009).

Further work was undertaken, based on both country-specific samples and combined samples. A summary of some of the main results are presented later in this report. However, one of the key

policy-relevant objectives of the VERHI project was to determine whether, the marginal rate of substitution for risk reduction for children relative to adults greater than one? At the aggregate level, the results are somewhat ambiguous. In the case of the conjoint choice experiment implemented in Italy the VSL for an adult (€4.0 million) is not statistically different from a child (€4.6 million). In the Czech Republic the values are statistically different at the 10% level, with values of CZK 24.5 million for the child and CZK 19.2 million for the adult. The figure below presents these figures,[1] alongside the marginal rate of substitution i.e. the ratio of these two values).

VSL and MRS in Italy and Czech Republic Based on CCE

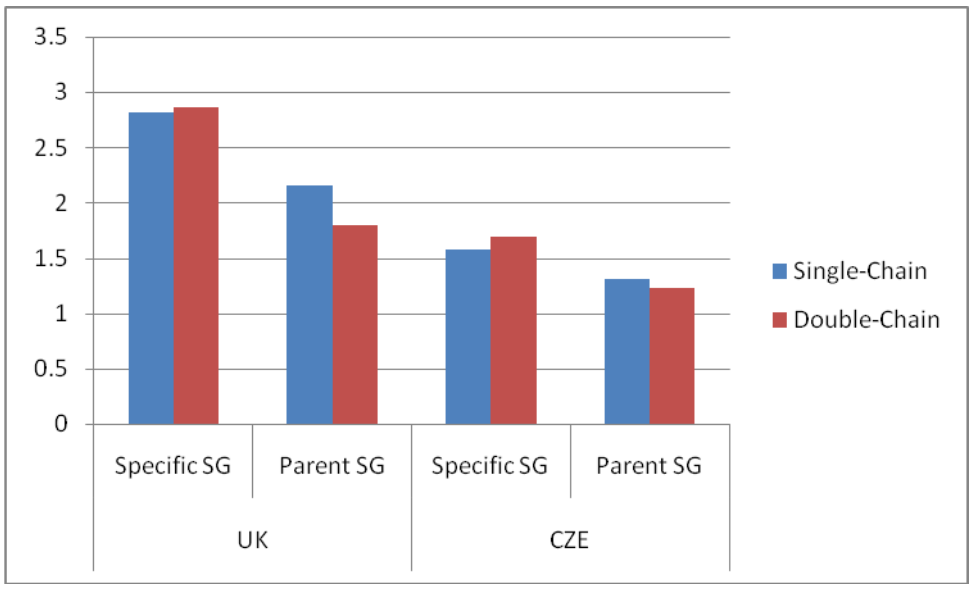


Using the chaining exercise the estimated values of risk reductions for children and adults are markedly different. We can first compare responses to the CV question in which respondents are asked what they would be WTP in order to avoid a poor health state. For a temporary poor health state the MRS is 1.8, and for a permanent poor health state it is 2.16. Given life expectancy, it is hardly surprising to find that the ratio is higher for the permanent health state, than the temporary one.

These values can then be 'chained' with the standard gamble (SG) question to obtain a VSL. On this basis the 'best' estimate (i.e. using a single chain) for an child VSL in the United Kingdom is £342,323 is significantly greater than that of an adult £121,411. The difference in the Czech Republic is less pronounced (€128,736 and €81,892), but statistically significant at the 5% level. However, there are concerns that there may be 'double-counting' associated with the chaining exercise, with the premium for child risk reductions applied twice. As such, in the figure below the MRS is presented when the parents' own standard gamble response is applied to both themselves and children. However, the Czech values when the adult SG response is applied are not statistically different for children and adults.

[1] Alberini and Ščasný (2009) "What is the VSL for Adults and Children?". Czech values obtained on basis of purchasing power parity exchange rate of 27 CZk/€.

MRS for VSL based on the Chaining Exercise in UK and CZE[2]



In general, the results from VERHI are consistent with the literature, finding some qualified evidence of a MRS greater than unity. However, this is not always the case. For example, the cancer VSL figures in Italy and the Czech Republic based on the conjoint choice experiments are higher for adults, raising the question whether the context or the baseline risk matter. The relative importance of context (and other risk and demographic factors) was the subject of econometric analysis and these results are presented in the deliverables listed below, and summarised in Chapter 2 of this report.

Main deliverables:[3]

The VSL for Children and Adults: An Application in the United Kingdom Using the Chaining Approach (D5A) Ian J. Bateman, Katy Bolt, Brett Day, Silvia Ferrini and Graham Loomes

What is the VSL for Adults and Children? Evidence from Conjoint Choice Experiments in Italy and the Czech Republic (D5A) Anna Alberini and Milan Ščasný

Value of Statistical Life for Child and Adult by Using "Chained Approach" And Person-Trade-Offs: Report from the Survey in the Czech Republic (D5A) Milan Ščasný and Hana Škopková.

Benefit Transfers by Country and by Cause: Evidence from the VERHI Project (D5C) by Milan Ščasný and Ståle Navrud

[2] Bateman *et al.* (2009) 'Can Stated Preferences Yield Robust Estimates of the Value of a Statistical Life?'

[3] Note that the proposed deliverable on analysis of the pooled data set has been included in the reports listed below due to the restructuring of the project (i.e. two-by-two comparisons).

International Workshop (WP7)

A workshop was held in Prague, Czech Republic on September 17th-18th, 2009 (http://www.oecd.org/dataoecd/61/10/42847281.pdf). The results from the project were presented by the researchers involved in the project, including Anna Alberini (University of Maryland), Graham Loomes (University of East Anglia) and Milan Ščasný (Charles University). Disccussants included Alan Krupnick (Resoureces for the Future), Mark Dickie (University of Central Florida), Michael Jones-Lee (University of Newcastle), and Per-Olov Johansson (Stockholm School of Economics). There were 54 participants in total, including academics and government officials. Presentations are available on the VERHI site (www.oecd.org/env/social/envhealth/verhi).

Main deliverable:

VERHI Workshop (D6A) – Charles University, Prague, Sept. 17th-18th

VERHI Workshop Synthesis Report (D6B)

Final Report and Further Disemmination (WP8)

In addition to the final activity report (and the deliverables mentioned herein), academic papers prepared thus far include three papers presented for peer review at the 17th EAERE Annual Conference in Amsterdam (June 24th-27th, 2009) (www.eaere2009.org), as well as papers presented at a number of other conferences. There are plans for at least eight more academic papers, submitted to leading journals such as the the *Journal of Risk and Uncertainty*, *Environmental and Resource Economics*, and the *Journal of Transport Economics and Policy*. For policymakers, a draft OECD report has been in preparation since early 2009 and has been presented to delegates of the OECD's Working Party on National Environmental Policies (ENV/EPOC/WPNEP(2008)9/REV1) on numerous occasions. This report will be published by the OECD in early 2010. OECD *Policy Briefs* and articles in the *OECD Observer* will be prepared.

Policy Support and Input (WP9)

Project progress and research outputs were presented to three meetings of the Working Party on National Environmental Policies. The reports were well received and the audience showed a great interest in the final results of the VERHI project. In addition, the OECD Secretariat presented the outcomes of the project at the 3rd International WHO Conference on Children's Health and the Environment (http://www.who.int/mediacentre/events/meetings/child_health_env/en/index.html) in Busan, Korea June 2009. Over 600 health professionals and government officials were in attendance. In addition, a dedicated session on the policy implications of the VERHI project was held at the Prague workshop. Government delegates participated actively. Further policy inputs are foreseen following project completion.

1.2 Overview of the Results of VERHI

1.2.1 Policy Review

The objectives of the policy review were two-fold:

- Examine the means by which environment-related health impacts are incorporated in EU member country government decision-making (and in other OECD member countries)
- Focus more specifically on the prevalence and use of economic valuation, particularly with respect to impacts on children

Pascale Scapecchi (OECD Environment Directorate) prepared a review of policy evaluation and valuation practices in OECD countries, both in the environmental and health fields. A questionnaire was prepared to collect information on policy evaluation and valuation practices in OECD Member countries and distributed to OECD member country delegates to the Working Party on National Environmental Policies and to the Group on Health (to obtain responses from both Environment Ministries and Health Ministries).

As a complement, the report proposed a review of current environmental regulation and legislation specifically targeting children in order to determine whether current regulation was taking into account children's specific vulnerability to environmental hazards. The main conclusion is that current environmental legislation does not generally target children, suggesting that impacts on children are not correctly reflected in environmental policy, despite the large number of policies and initiatives undertaken in OECD countries. More specifically, environmental regulations should account for children specific vulnerability to environmental hazards and better integrate health concerns for children.

The policy review was presented at the first VERHI Research Consortium and Advisory Group Meeting, held in Paris on the 6-7 November 2006, as well as at the WPNEP meeting on the 30 May 2007. The report has been revised according to comments and suggestions provided during these meetings.[4]

[4] The report is available at http://www.oecd.org/document/23/0,2340,en_21571361_36146795_38165463_1_1_1_1,00.html

1.2.2 Methodological Review

The objectives of the methodological review were threefold:

- Review the economic theory for proper characterization of age, latency and other risk and population characteristics in the WTP and QALY frameworks.
- Assess the relative strengths and weaknesses of revealed and stated preference methodologies, and the possibility of combining in a single survey instrument.
- In both of these areas, examine the implications the elicitation of values from children as well as adults

In this work package the theoretical and empirical literature were reviewed in order to provide a basis upon which to select the appropriate methodologies to value environmental health impacts across patient and risk characteristics. Given the focus of the project, particular attention will be paid to the valuation of impacts for children, as well as differences according to age and latency.

Three reports were prepared to assist the research consortium:

- in the selection of the appropriate valuation framework to apply in the context of the valuation of environmental health risks to children (report prepared by James K. Hammitt (Harvard University) on "Methodological Review of WTP and QALY Frameworks for Valuing Environmental Health Risks to Children");

- in the preparation of the scenario design (report prepared by Alistair Hunt (Bath University) on a "Review of Revealed Preference Studies"); and,

- in the identification of an environmental risk factor which is likely to lead to credible estimates for both adults and children (report prepared by Alistair Hunt (Bath University) on "Review and Summary of the Epidemiological Literature on Children's Health Risks Associated with Environmental Exposures").

These three reports presented at the First Research Consortium and Advisory Group Meeting, held in Paris on the 6-7 November 2006.[5] Based upon the findings from these reports and discussions raised during the meeting, it was decided that the surveys will be based on a willingness-to-pay approach. Different survey designs were then tested in the three countries involved in the project in order to determine which valuation methodology and which environmental risk factor is the most appropriate for this very specific context.

[5] They can be downloaded at http://www.oecd.org/document/23/0,2340,en_21571361_36146795_38165463_1_1_1_1,00.html

1.2.3 Survey Development Work

Presenting Risks

As the review by Hunt and Orgiz (2006a) indicated, baseline environmental mortality health risks are generally low and unfamiliar, and particularly so for children. Communicating such risks to respondents is a challenge for researchers. Moreover, low baseline risks leave little margin for risk reductions (changes in risk with the intervention). As such, a considerable amount of survey development work was devoted to the identification of risks which would be 'meaningful' for respondents, the development of risk communication strategies, and specific scenarios which were meaningful to respondents.

Low-Probability and Unfamiliar Risks

As a first step in exploring such issues, a laboratory experiment using 99 students from University of Anglia as respondents was implemented in January 2006 to investigate the separate and dual influence of both risk probability comprehension and familiarity with the good upon responses. Experimental subjects were presented with three goods of decreasing familiarity:

1. Avoiding losses of money (£75)
2. Avoiding a temporary stomach complaint
3. Avoiding a condition causing temporary blindness

These goods were provided at a variety of probabilities and WTP sought. A first test combining both the familiarity and risk perception issue was to elicit, for each of the three goods, respondents' values for reducing risk from two different levels:

a. from 5/10 to 0/10, and
b. from 1/10 to 0/10.

A simple scope sensitivity test then compared the consistency of values obtained from these two scenarios, testing the simple hypothesis that values obtained for avoiding risk (a) should be different than those obtained for avoiding risk (b). Note that both of these risk levels were deliberately chosen to be much more familiar probabilities than the small risks typically used in VSL studies and so any anomalous insensitivity to scope is likely to underestimate that which might occur in real VSL valuations. To go some way to address this we also elicit, for each of the three goods, respondents values for the following further risk reductions

c. from 100/1,000 to 0/1,000, and
d. from 20/1,000 to 0/1,000.

Again a scope sensitivity test examined the hypothesis that the value of avoiding risk (c) is different than associated with avoiding risk (d). A second analysis looked at within-good valuations of different representations of what is the same risk. For each good the value of reducing risk from 1/10 to 0/10 was compared to the value of reducing risk from 100/1000 to 0/1000. Here the null hypothesis is of course that

the values should not be significantly different. Findings from the first test, the scope sensitivity tests, are presented in the Table below. The upper three rows show the values associated with risk reductions (a) and (b) and the final three rows show findings for risks (c) and (d).

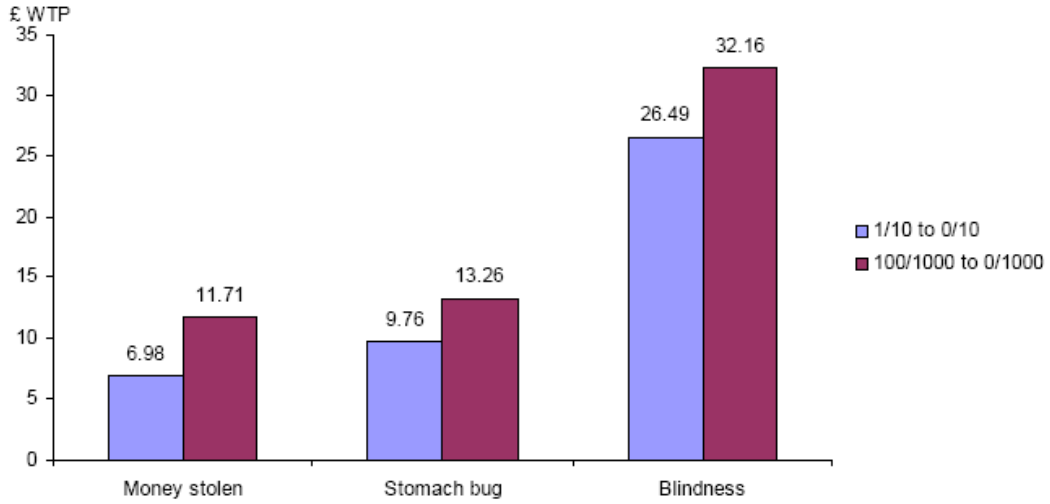
Tests of scope sensitivity in split-samples

	Mean WTP (£)		H_0[1]: WTP (larger risk reduction) = WTP (smaller risk reduction)	
	Larger risk reduction	Smaller risk reduction	*t*	p-value
Risk in 10	*5/10 to 0/10*	*1/10 to 0/10*		
Money stolen	18.35	8.46	4.182	.000
Stomach bug	22.87	13.03	2.622	.005
Blindness	57.36	34.84	1.202	.116
Risk in 1,000	*100/1,000 to 0/1,000*	*20/1,000 to 0/1,000*		
Money stolen	8.91	7.83	.416	.339
Stomach bug	10.67	8.53	.903	.185
Blindness	24.44	25.64	-.132	.448

Results show that, when risks are presented as the more readily comprehended chances out of 10 and the goods are familiar (such as avoiding money being stolen and the stomach bug) respondents present a degree of sensitivity to the scope of the risk reduction, and WTP is significantly different (as can be seen from p-values in the fifth column). On the other hand, when the goods are less familiar (avoiding temporary blindness) and/or risks are presented as chances out of 1000, respondents' WTP is not significantly different for reducing risks which are in objective terms five times different from each other. These findings indicate that the theoretical consistency and hence validity of SP-based estimates of VSL declines both as the degree of familiarity falls and as the level of the risk denominator increases. This is, as mentioned, a common finding in the literature (see *e.g.* Braathen *et al*. 2009).

The results of the second test, whether WTP is the same for the same risk change displayed in two different ways for the three goods, are given in the Figure below. The figure shows that for each good respondents state a higher WTP to reduce risks from 100/1000 to 0/1000 than from 1/10 to 0/10, although these changes are the same. In absolute terms the discrepancy is roughly similar in each case. It appears that the larger numbers used as the numerator and denominator make respondents feel that risks are somehow greater, responding with higher WTP values. This is consistent with previous findings (see, for example, Beattie *et al*. 1998.)

Mean WTP for equivalent risk reductions for different goods



The importance of scope effect was confirmed in personal interviews with 14 respondents in the Czech Republic in May 2007. The strong framing effects identified in the lab results emphasise the importance of identifying risk which are familiar and meaningful to respondents, and communicating such risks to respondents in a manner which reduces potential framing effects.

Perceptions of Environmental Health Risks

Given the apparent importance of 'familiarity', considerable efforts were made to determine which 'environmental' risks were most meaningful to respondents, and how the perception of such risks differed from other types of risk more commonly assessed in the literature (i.e. road traffic accidents). To this end, four focus group discussions (approx. 26 parents) were held in Milan and Mestre in September 2006, in which parents were requested to indicate their: (i) concerns about their children's health; (ii) perceptions of environmental exposures and their effects on their children's health; and, (iii) opinions on how such exposures should be addressed (through government regulations and intervention, or individual behaviors). The different 'environmental' pressures explored included: air pollution, pesticides, mercury, pathogens, drinking water, endocrine disruptors and lead, as well as other non-environmental risks (i.e. road-traffic accidents).

In the first instance, respondents were requested to indicate whether they had heard of particular risks, and if so did they feel that their children were vulnerable to such risks. Amongst the environment-related concerns air pollution and pesticides consistently rank highest in terms of awareness and perceived risk for their children, with the majority of respondents indicating it was a concern. Respondents were also requested to prioritise different possible initiatives, taking into account that resources are limited. Not surprisingly, measures to reduce pollution are given the highest priority, by some margin.

Priority for Government Interventions Given to Different Concerns

	Low or no priority (1)	(2)	Medium priority (3)	(4)	High priority (5)
Reduce pollution	0	0	0	2	14
Improve the school system	0	0	13	2	1
Tighten food quality regulations and inspections	0	0	1	4	11
Improve hygiene in schools	0	1	5	4	6
Create public parks and playgrounds	0	2	5	4	5
Improve road safety	0	0	1	7	8
Initiatives to improve children's hospital stays	1	1	1	5	8
Improve children's emergency rooms	0	0	4	6	6
After-school recreational and educational activities for children	0	4	6	5	0

Interestingly, the results of the focus group discussions are consistent with the epidemiological evidence, insofar as that when people think about pollution, they think first and foremost about air pollution. They seemed knowledgeable about the short-term effects of air pollution (bronchitis, allergic respiratory ailments) as well as the long-term effects (chronic respiratory illnesses, cancer). This was confirmed in personal interviews undertaken in Venice, Vittorio and elsewhere in Northern Italy in January 2007. Interestingly, cardiovascular diseases were seen as primarily a consequence of lifestyle, and not exposure to environmental risks.

A set of of personal interviews and focus groups was undertaken with 15 parents in the Czech Republic in October 2006 in order to explore similar issues. In this case parents indicated that they felt their children were directly affected by air pollution (11), risk of road traffic accident (10), noise (5), mercury and heavy metals in food (4). Testing undertaken in January 2007 in the Czech Republic (18 personal interviews) confirmed the importance of air pollution, although in theis case road traffic accidents were cited somewhat more frequently.

In survey development work undertaken in the United Kingdom, a scenario was presented to respondents in which respiratory problems arising out of exposure to air pollution resulted in hospitalisation. However, many people felt that could only happen to people with existing respiratory problems (such as asthmatics), and they did not believe they themselves would be affected.

In summary, the main finding from the personal interviews and focus group discussions was, therefore, that an environmental context is feasible and credible. The findings suggested that the risks associated with the environment and its health impacts are relevant for respondents. They were broadly familiar with most of the impacts presented, especially those related to air pollution. As such, on this basis it was decided that air pollution and associated health impacts (e.g.

respiratory problems) are a good candidate for the valuation scenarios. In addition, a majority of respondents in the focus group discussions undertaken in the Czech Republic were aware of concerns related to water pollution, which was also considered as the basis for an alternative scenario. The other environmental pressures considered did not seem to be meaningful for respondents, and it was these two which were retained in the final survey instruments.

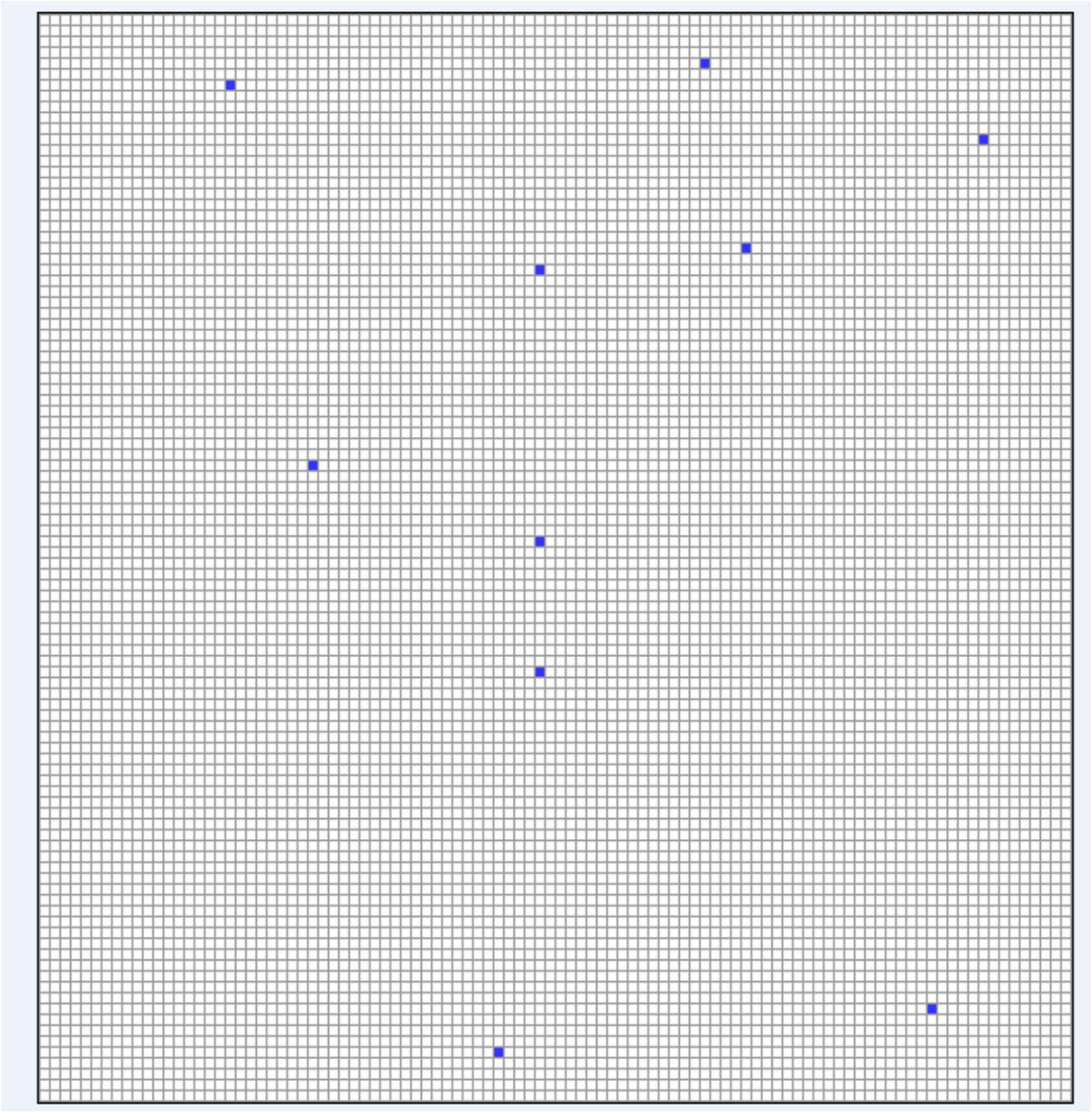
Communication of Quanitative Risks

With relatively low baseline risks (and thus potential risk reductions) the means of communication of risk is central to survey design. In the survey development work undertaken it Italy and the Czech Republic, extensive testing of different visual aids was undertaken. In particular the use of grids has been used previously with success (Corso *et al*. 2001), and their use in the context of the VERHI project was examined. While grids with 100,000 squares were considered, this was not feasible, given the means of survey implementation (CAPI) in which the size of the screen poses a constraints. However, the use of grids with 10,000 squares clearly helped respondents understand the probability figures presented in the CCE scenario. Different risk reductions were proposed, generally involving small probabilities.

An example of these grids is illustrated in the two figures below. These figures show that 10 people out of these 10,000 will die within the next 5 years, while 9,990 people will survive that period. The dark squares can be scattered to give an idea of randomness, or placed next to one another to give a sense of the proportion.

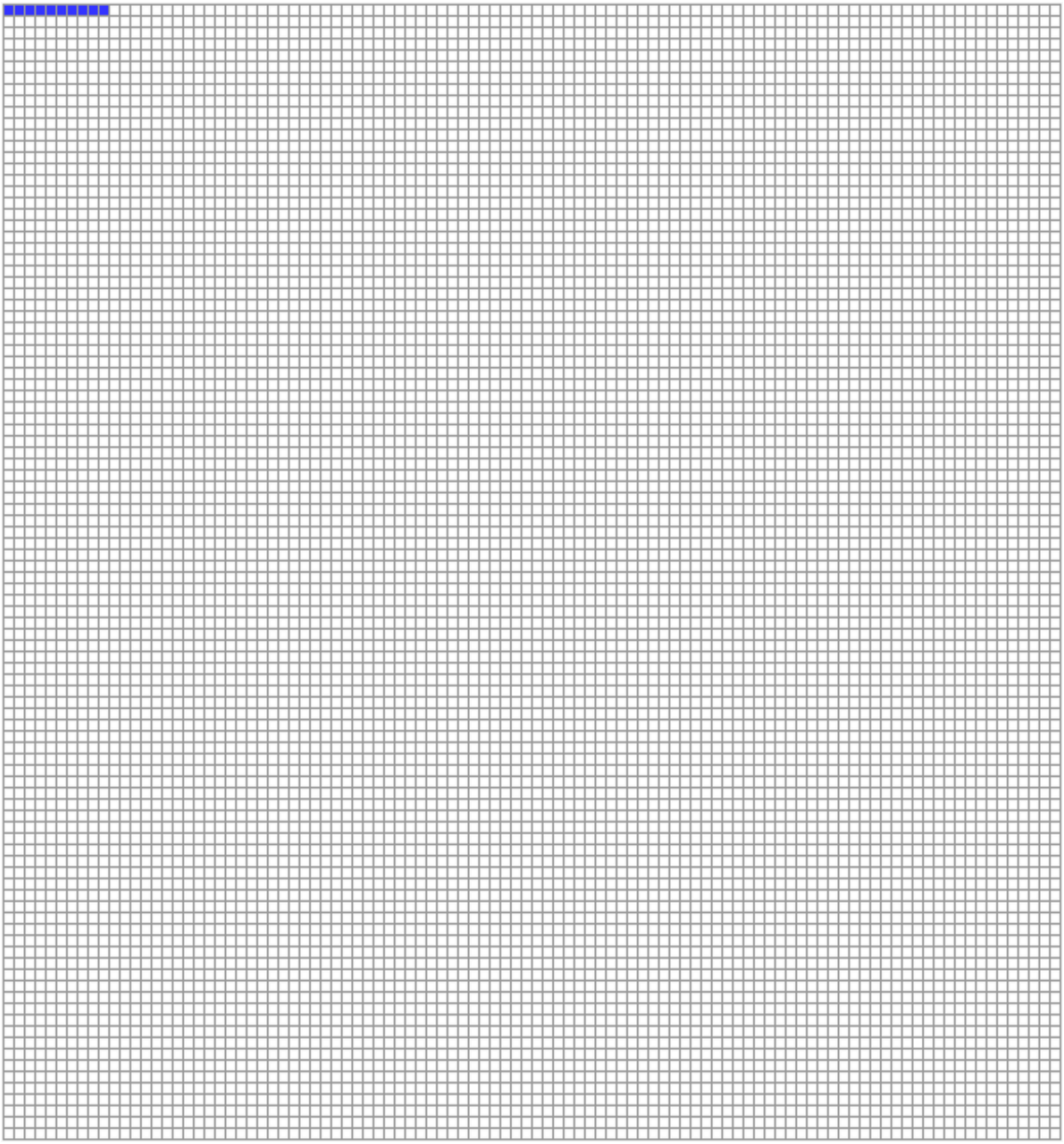
Risk Communication (Grid A)

= DEAD = ALIVE



Risk Communication (Grid B)

= DEAD = ALIVE



In all of the survey development work undertaken the use of grids proved to be readily understandable to respondents. However, one interesting finding was that if the numerator in the risk reduction presented is one, respondents had a tendency to identify this child as their own

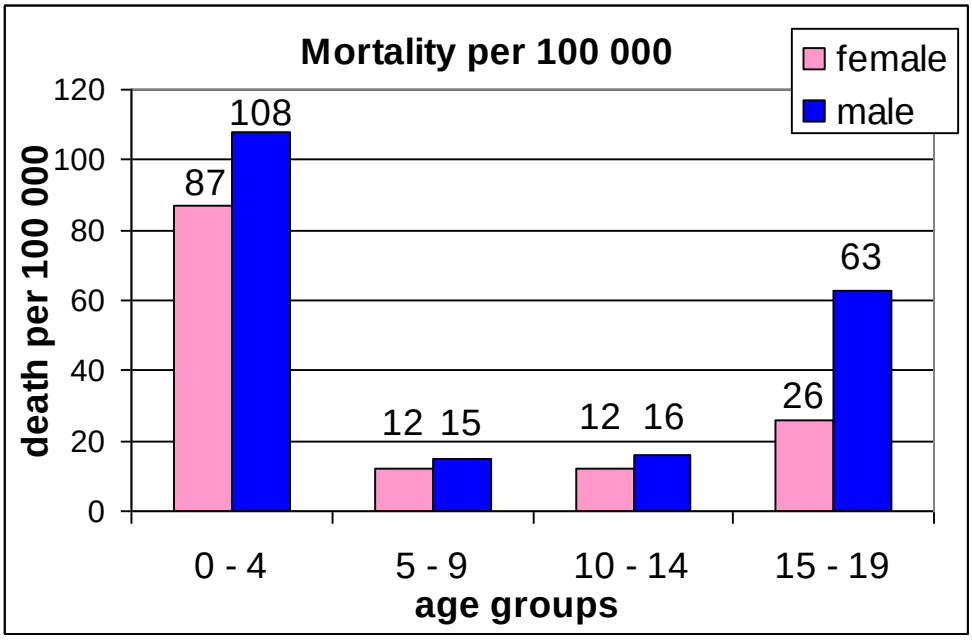
(Czech Republic, January 2007).[6] This has important implications for values estimated, and should be avoided.

These grids were complemented through the use of histograms which give mortality rates, based on data from national and European statistical offices (*e.g.* ISTAT and EUROSTAT). This data were also provided on charts - to familiarise people with such concepts and to "personalise" the risk that was being considered. This helped reduce the degree of uncertainty surrounding the perception of the risk presented in the scenario.

For instance, respondents were presented with probabilities of dying from cancer over the next five years, differentiated by age group. Similar graphs were provided to the respondents for road accident and respiratory disease probabilities. As such, respondents could determine their baseline risk, and could more easily accept these probabilities (because they come from "official" or "reliable" sources).

In this case, risk reductions can be presented as histograms, with the height of the additional bars reflecting the reduced risk following the intervention, the difference representing the associated risk reduction. This was readily understood in all of the testing work undertaken. The data can also be disaggregated (e.g. by gender as in the figure below for the Czech Republic) in order to ensure that respondents understand differences in baseline risks for different groups.

Communication of probability and risk



In some of the focus group discussions undertaken (*e.g.* in Rome in October 2006) survival curves were also presented. Changes in risk reductions could then be presented in terms of shifts outward in the survival curve. Some respondents spontaneously mentioned the 'positive' spin this gave on changes in risk.

[6] Disconcertingly, some respondents did not protest to the presentation of risk reductions which exceeded baseline risks.

However, there was some confusion about the precise meaning of this curve (and its relationship to other means of risk communication). As a test, one interviewer provided their focus with an explanation of the meaning of the curve, while another interviewer did not do so with another group. The degree of understanding was very different, indicating the need for considerable inputs from the interviewer. Given the likely means of survey implementation and time constraints, this approach was not further considered.

Based upon this work it was decided that the principal visual means of risk communication would be via grids. However, with the number of squares in the grid constrained to 10,000 in order to present credible baseline risks and risk reductions to respondents, it was found in the course of the survey development work that risks had to be aggregated over a number of years in order to have reasonable 'numerators' for the baseline risk and risk reduction. Moreover, such an approach was consistent with the results of other work (*e.g.* Czech Republic in Oct. 2006) which indicated that respondents preferred to pay for risk reductions through annual payments equal to the period of risk reduction. On the basis of these results, it was decided that mortality risk over five years would be used, both to communicate risk and in the scenarios for the conjoint choice experiments.

Accounting for Risk Characteristics

It is well-known that different risk characteristics can have an effect on the estimated WTP for reductions of risk of equal magnitude. As such, considerable effort was devoted toward the testing of alternative presentation of risk characteristics, and their implications for values obtained.

In focus group and personal interviews undertaken in Italy (Janurary 2007) and the Czech Republic (October 2006 and January 2007), respondents were requested to indicate the level of 'dread' they attached to different mortality risks (road traffic accidents, leukemia, chronic respiratory illnesses, cancer, workplace accidents, etc.). In general, the results do not indicate the presence of a significant cancer 'premium'.

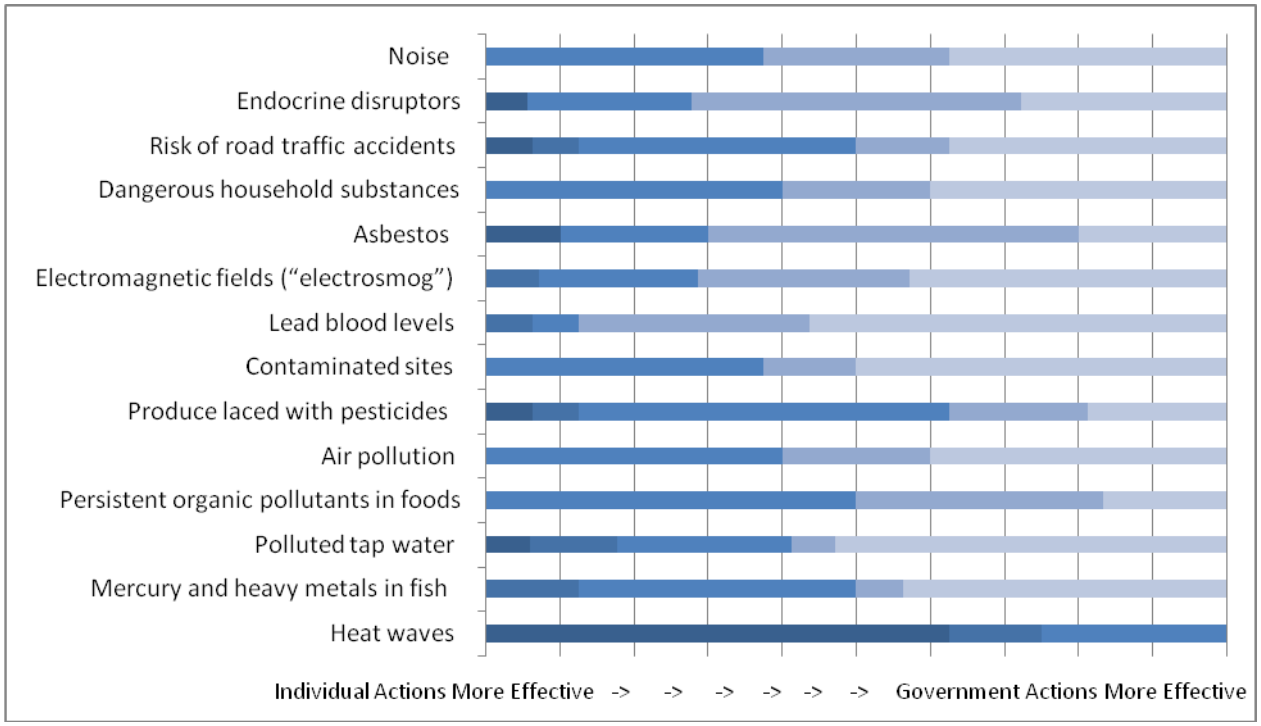
For instance, of 11 personal interviews conducted in the Czech Republic in October 2006, only two respondents declared that they would prefer a risk reduction of 4 in 100,000 for cancer relative to 8 in 100,000 for traffic accidents. Indeed, in the survey development work undertaken in Italy in January 2007, respondents appeared to express more 'dread' with respect to violent or 'drawn-out and protracted' deaths, than cancer *per se*. Other areas cited in personal interviews in interviews undertaken in Northern Italy in January 2007 included AIDS and neonatal mortality.

The degree of "involuntariness" and 'controllability' of risk may also significantly affect the valuation of children's health. Research has shown that individuals generally prefer voluntary risks to involuntary ones and that the degree of "risk voluntariness" could therefore have impacts on the WTP (Fischhoff *et al*., 1978; Slovic, 1987). In the context of valuation of children's health, this may have a greater influence on the estimates. Those risks which are "voluntary" for adults might be considered "involuntary" for children, since at least some risk exposure decisions are made on their behalf by their parents. Therefore, parental WTP to protect their children's health may be significantly affected by the perceived degree of voluntariness of risks faced by the children.

Interestingly, the focus group discussions also indicated that cancer was not only associated with 'dread', but also had implications for perceived 'controllability'. In the survey development work undertaken in the Czech Republic in October 2006, respondents seemed to perceive cancer as "destiny", and were thus less amenable to risk reductions.

A key determinant of the degree of 'voluntarism' of a particular risk is the perceived extent to which individual preventive action will be effective in reducing the risk relative to government programmes. Results of focus group discussions in Italy show that, in general individual actions are not considered as effective as public programmes except in limited areas (e.g. heath waves). (see figure below). This finding was confirmed in interviews held in the Czech Republic, where there was a strong feeling that 'the state should solve 'environmental' concerns, while for road accidents the individual is better able to solve the problem him or herself (October 2006 and January 2007).

The Effectiveness of Public and Private Interventions



Given the inherent nature of most environmental health risks for children, from the outset of the project it was seen as important to ensure that issues of latency were addressed in a robust manner. In the focus group discussions held in Italy in September 2006, participants were requested to indicate whether the risk reduction was incurred immediately or after some time. Interestingly there was considerable congruence amongst the respondents concerning the links between air pollution and respiratory problems and cardiovascular diseases, with most respondents suggesting between seven and 15 years. However, there were some respondents who felt it might be 20 years or more.

This was confirmed in later testing undertaken in Rome in October 2006. In sessions the interviewers explored people's decisions regarding the size of risk reductions and their timing. The responses indicated that people were able to make such choices – trading off smaller risk reduction incurred immediately with larger ones incurred in the future.

In the interviews and focus groups conducted in the Czech Republic in October 2006 respondents were requested to choose between risk reductions of 15 in 100,000 which occurred in 25 years, against one of 10 in 100,000 in ten years. The latter was chosen by the majority of respondents. Part of the reason cited by a number of respondents was that the child would necessarily be an adult by the time the health impact arose with the longer latency period.

Making trade-offs

There are two main approaches to estimating the WTP for a mortality risk reduction. The first approach, revealed preference studies, uses actual behaviors to infer the rate at which individuals trade off income for safety, and includes compensating wage studies, consumer behavior studies, and hedonic pricing approaches. For example, labor market studies (see Viscusi and Aldy, 2003) relate wage rates to the risk of fatal and non-fatal accidents on the job, reasoning that workers would be prepared to accept a riskier job only for higher pay.[7] Other studies have related the price of automobiles to the risk of dying in an accident associated with an automobiles safety features (Atkinson and Halvorsen, 1990; Andersson, 2005), or the value of a home to the risk of dying for environmental exposures in the neighborhood (Gayer *et al.*, 2000, 2002). In the case of children mortality, Jenkins *et al.* (2001) have used expenditures on bicycle helmets to infer the VSL for children of various ages and adults, and Blomquist *et al.* (1996) have relied on the time spent fastening car seatbelts. Davis (2004) uses a cluster of children's leukemia cases in a Nevada community and housing prices to infer the value of a statistical case of child leukemia.

The second approach to estimating the VSL—stated preference studies—queries individuals about what they would do under specified hypothetical circumstances. Stated preference methods include contingent valuation (CV) and conjoint choice experiment surveys. Unlike revealed preference studies, stated-preference studies can be designed to cater to any population and any risk of interest (see Bateman *et al.*, 2002 for a recent review). In addition, since they rely on hypothetical scenarios created by the researchers, stated preference studies can be designed to deal squarely with the issue of latent risks. For these reasons it was decided to implement stated preference surveys.

As a means to develop meaningful scenarios, considerable work was undertaken to assess the capacity of respondents to make trade-offs between affected populations, different risk attributes, etc… In this section this work is summarised, classified by the nature of the choice (i.e. direct contingent valuation for a programme or product, contingent valuation through location decisions, person trade-offs, risk-risk trade-offs, and multi-attribute choice decisions).

Direct Contingent Valuation

While the notion of basing all the results upon the implementation of a contingent valuation scenario was quickly discarded, it was seen to be important to include such an approach as an element within the survey instruments, and testing was undertaken on alternative CV methods. In CV surveys concerned with the valuation of risk reductions, respondents are usually queried

[7] See Schnier *et al.* (2008) for a somewhat different approach, based on a commercial fishing vessel captain's decision to go fishing in the Alaskan red crab fisheries as a function of weather and policy variable intended to improve safety. Schnier *et al.* obtain VSL values of $4.6-4.9 million, and attempt to disentangle the value of crew members from that of the vessel's captain.

directly about their willingness to pay for a public program, product or good that reduces their risks. CV surveys were used, among others, by Johannesson *et al.* (1996a), Johannesson *et al.* (1997), Krupnick *et al.* (2002), and Alberini and Chiabai (2007a, 2007b) for samples of adults and the elderly. Dickie and Gerking (2006) present the results of a CV survey that elicits WTP to reduce the risk of contracting fatal skin cancer in adults and children.

In the case of the UK a contingent valuation scenario was proposed in a pilot involving 300 respondents in the Cambridge area in August September 2006. The questions for the contingent valuation part of the questionnaire were based on the survey in Krupnick *et al.* (2002). In order to present respondents with a comparison of their overall mortality risk they were presented with risks from some of the largest single causes. The scenario presented involved a risk reduction (either 5 in 10,000 or 1 in 10,000) arising from the purchase product which would reduce mortality risks over the course of 10 years.

A large percentage provided a WTP of zero. More significantly, a relatively high proportion of these can be considered as 'protests' (see table below). This raised concerns about the viability of using a direct CV question to elicit WTP for a mortality risk reduction.

Percent of total sample who stated a contingent valuation WTP of zero by reason

	5/1,000		1/1,000	
	No protest	Protests	No protest	Protests
Adult	41.3	7.0	64.0	7.0
Child	20.0	4.7	45.3	5.0

In survey development work undertaken in Rome in October 2006, and in Prague in May 2007 and March 2008, a scenario was presented which proposes to the respondent the possibility to move from his/her actual city to two hypothetical cities whose attributes vary according what we want to value. The "City A v. City B" scenario was presented as follows:

> "*Imagine that there are two cities that are identical to each other and to the city where you actually live in all respects, except for the mortality rates and cost of living.*
>
> *In city A, X in 10 000 children aged 5-9 (same age group as one of the respondent's children) die every year. The cost of living is the same as where you live now. In city B, Y (Y<X) in 10 000 children aged 5-9 die every year. In city B, the cost of living is EUR 1000 a year higher than in city A (and than where you live now).*
>
> *Where would you prefer to live, in city A or city B?*"

With appropriate follow-up questions, the "City A v. City B" alternative can provide an exact indifference point between cities A and B - determining precisely the value of the risk reduction. The "City A v. city B" questions elicit information about the WTP and VSL for any desired age group. However, we found that this approach resulted in disproportionately large estimates of the VSL based on city A-city B questions. The responses to such questions were not sensitive to the size of the risk reduction assigned to a response, suggesting that people were either not paying attention to key elements of the questions, or were answering simply to provide evidence that good health is important to them. This question was subsequently dropped from the questionnaire

and replaced with a simple dichotomous-choice question about the WTP for a specified risk reduction.

Conjoint Choice Experiments

In conjoint choice experiments, respondents are asked to select one of K hypothetical scenarios ($K \geq 2$), where the scenarios are described by a vector of attributes, including mortality risk reduction and cost. Researchers interpret and model the responses to conjoint choice surveys by assuming that individuals pick the alternative to which they attach the highest utility. In empirical work, respondents are frequently asked to engage in several choice tasks within the same questionnaire. This increases the number of observations available to the researcher, holding the total number of interviews the same, and allows the researcher to examine how support for a policy or risk-reducing measure changes as the attributes of the policy are varied.

Conjoint choice experiments were used, among others, by Tsuge *et al.* (2005), who examine perceptions and the value of avoiding events with a small probability of occuring and high fatality counts. Alberini *et al.* (2007) study VSL and preferences for permanent cleanup of contaminated sites, and in Tonin et al. (2009) respondents engage in tradeoffs between public programs that rehabilitate contaminated sites offering cancer risk reductions and reuse of the land.

The decision, to pursue CCE methodology for at least one of the survey instruments necessitated that considerable survey development work was devoted toward more general issues of cognitive burden. For instance, in personal interviews conducted in the Czech Republic in January 2007, the difficulty of making choices was assessed with different numbers of attributes. Initially, the respondent might be asked to choose between two programmes which varied only according to the size of the risk reduction, its duration, and period of latency

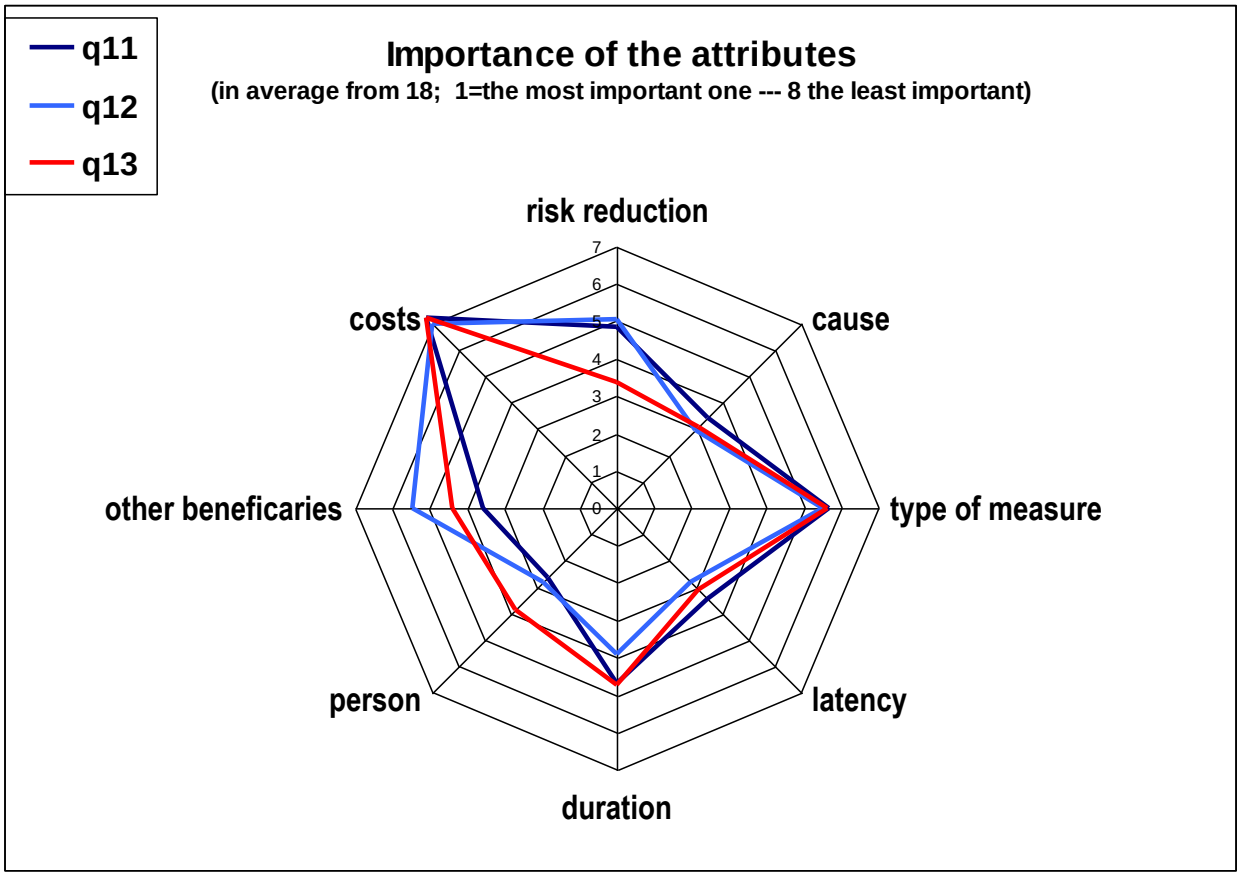
The number of attributes was incrementally increased from three to maximum of eight (risk reduction, cause, type of measure, latency period, duration of risk reduction, identity of beneficiary, whether other beneficiaries, cost). Respondents were requested to indicate how difficult they found different choices to be with different numbers of attributes. With six attributes there is a distinct increase in the perceived difficulty.

However, it is not only the number of attributes which affects the difficulty of responding. For instance, the introduction of the context (*e.g.* cancer, car accident, respiratory disease) appeared to have a disproportionately large effect on difficulty of the choice. In addition, as noted above, addressing the question of latency appears to be particularly difficult for respondents, and considerable care was taken to address this in the survey development work.

In particular, the relationship between the length of the latency period and the identity of the respondent (self or child) was closely evaluated. Irrespective of the identity of the beneficiary, beyond a certain latency period (approximately 15-20 years), the immediate risk reduction was systematically chosen irrespective of relative size. This appeared not to be due entirely to discounting per se, but also to perceptions about possible improvements in medical care over the period.

The relative importance of different attributes in the choices was also assessed, and the results of an analysis undertaken in the Czech Republic (based upon work undertaken in January 2007) are presented in the figure below. Latency and cause are very important. In addition, it is interesting that the relative importance of the different attributes does not vary greatly with precise choices presented. These results were used to inform the design of the final survey instruments.

Relative Importance of Different Attributes in CC Decisions



However, in the first large-scale pilot study undertaken we were dissatisfied with the conjoint choice experiment questions, in the sense that they also resulted in unrealistically large VSL figures and discount rates. After completing the self-administered questionnaire, respondents filled out a pen-and-paper questionnaire that elicited information about their perceptions of pollution problems and knowledge of various types of exposure to contaminants and pollutants. A preliminary analysis of the data from this pen-and-paper questionnaire shows that to our respondents the main pollution problem is air pollution, and that they all feel heavily exposed to it. This is consistent with our findings from the focus groups in Milan, with actual particulate levels in that city, and with the fact that high-pollution days and days with violations of the air quality standards receive extensive coverage in the media (newspaper, internet, TV).

In addition, results from the second large-scale pilot indicated that respondents, when faced with two risk-reduction profiles, would always opt for the one that delivers the risk reduction sooner, even if it was extremely expensive. For this reason, we decided to amend the experiment design

for the final survey so that the profiles contained in each choice set would be showing the same latency period. The latency periods would, however, be varied across choice sets within a respondent and across respondents. Monte-Carlo simulations showed that this approach would allow identification of the discount rate, one of the parameters with we wished to estimate in this research project.

The Chaining Exercise/Standard Gamble

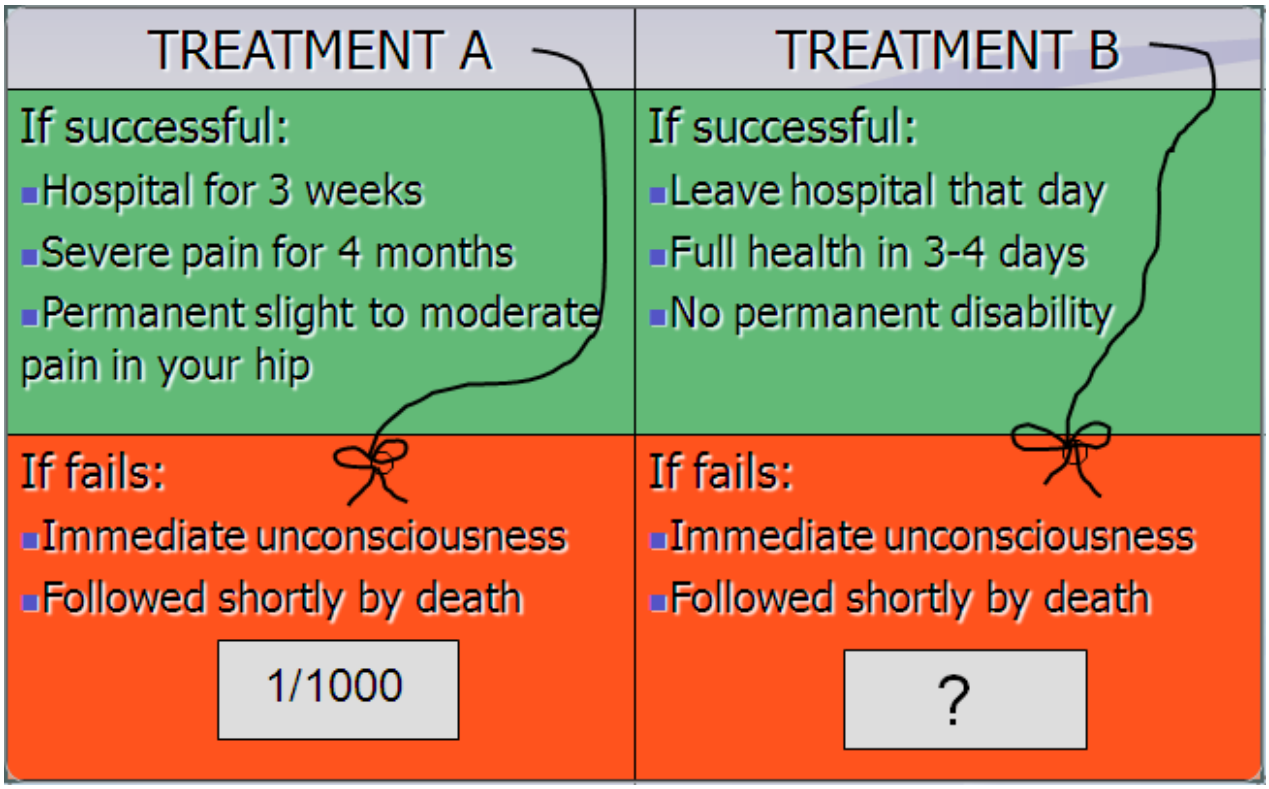
Within the class of stated preference approaches, it is also possible to apply a hybrid method known as the chained approach (Carthy *et al.*, 1999, Beatty *et al.*, 1998). Recall that the VSL is defined as $\frac{\partial WTP}{\partial R}$, where R is the risk of dying, holding utility constant. The chained approach holds that the individual's valuation effort can be facilitated if one first places a value on an illness that is relatively familiar and is experienced with probability 1, and then establishes his or her rate of substitution between that illness and the risk of death. In other words, $\frac{\partial WTP}{\partial R} = \frac{\partial WTP}{\partial M} \cdot \frac{\partial M}{\partial R}$, with the respondent valuing each of the two terms in the right-hand side of this equation.

The initial survey development work undertaken in the UK in August/September indicated that the potential for zero and protest responses with a direct CV scenario for mortality risk reductions was significant. For this reason, the possibility of 'chaining' a WTP question for morbidity risk reductions, with a second question in which morbidity and mortality risks were traded off against each other.

In the first instance, a modified standard gamble question was tested in which respondents were told to imagine that they have been injured or have become ill and are taken to hospital where the doctors tell them that if they are not treated then they will die. However, they are told that there are two possible treatments available to them and this time both are free of charge:

> ***Treatment A:*** *If successful, the treatment will result in the respondent experiencing the consequences of a specified non-fatal injury or illness. However, if the treatment is unsuccessful then the patient would fall unconscious and die shortly afterwards with probability of 1/1,000 (this risk can be set at any level).*
>
> ***Treatment B:*** *If successful, this treatment will result in a return to normal health after a couple of days but if unsuccessful there is a chance that the treatment will result in immediate unconsciousness followed shortly by death (this risk is unspecified).*

Example of Trial Modified Gamble Question



The respondent is asked for the highest level of risk she would accept for treatment B given that treatment A has a risk of failure of 1/1,000 (or whatever level of risk is set by the researcher). As treatment B has a better successful outcome than treatment A, i.e. full health versus some level of remaining disability, it is expected that the respondent is willing to take on some additional mortality risk for the chance of this better successful outcome. While this step requires respondents to deal with small changes in risk, it does not involve a wealth-risk trade-off and is therefore thought to be easier for respondents to answer.

Overall, the risk-risk trade-off appeared to be well-understood and respondents were engaged when providing their answers. However, many respondents reported that the trade-off in the modified standard gamble (with two treatments) was difficult, and this point was taken into consideration when designing the final survey instrument. Specifically, the risk-risk trade-off exercise using a standard gamble structure where only one risky treatment is presented to the respondent (more details below).

Person Trade-Off

As a means to assess the 'marginal rate of substitution' between reducing risks for adults and children, people are asked to choose between two programmes in which the programmes differ with respect to the beneficiary populations. While this can not be used to derive a VSL it can provide valuable information for policy makers (i.e. by adjusting the anchor VSL figure depending upon the composition of beneficiary populations).

Two alternatives were tested. In one case a policy intervention is proposed which results in different numbers of lives of adults and children being saved. Several pairs of programmes are proposed to the respondents, which then allows for the estimation of the trade-off point. This PTO approach was tested by the Italian research team and the Czech Republic, as follows:

> "*Suppose now one has to choose between other public health interventions. Intervention A saves 10 lives in 10 000 children aged 0-4 this year, whereas this year intervention B saves 30 lives in 10 000 adults older than 30.*
>
> *As before, there is funding for only one of these two interventions. Which would you choose? (Please check the appropriate answer.)*
>
> - *Intervention A: saves 10 lives in 10 000 children aged 0-4*
> - *Intervention B: saves 10 lives in 10 000 adults older than 30*
> - *A and B are equally attractive.*"

However, the ratio was exceedingly high with respondents favouring relatively programmes in which a relatively small number of children are saved (relative to one in which a very large number of adults are saved). An alternative involving the provision of medical treatments tested well, providing credible ratios.

On the basis of the extenisive survey development work undertaken as part of the VERHI project, the main findings are summarised in the table below.

Main findings from the survey development work

ISSUES TO BE ADDRESSED	EMPIRICAL EVIDENCE	SUGGESTIONS
Third party elicitation	The parental perspective was adopted in the CCE and the chained approach as empirical evidence suggests it is the most appropriate manner to reveal children's preferences. Although it may be affected by altruism and risk perception, it worked well in both cases. Parents did state higher WTP to reduce risks to their children than to themselves.	The parental perspective was adopted in the final instrument. Although a collective approach seems preferable, it has never been used in an empirical context, probably because of modelling complexity. As such, a unitary approach was adopted.
Latency issues	People understood very well the difference between immediate and latent risks. People tend to favour reducing immediate risks when the programme deals with adults.	Latency attributes could be included in the final survey instrument
Environmental context	Respondents declare being aware of environmental health issues and their exposure to those hazards. In the CCE, context plays an important role in decision-making. The chained method has not been tested in an environmental context, and pre-tests suggest that a context-free scenario would work better.	For policy-making purposes, the final survey instrument should use an 'environmental context, as far as possible. However, for purposes of comparison, other contexts should also be included.
Health impact	Respiratory diseases worked well in the CCE but not as well in the chained method. Road accidents worked well in both approaches but they are not environment-related hazards. Cancers (tested in the CCE) worked well	Respiratory ailments, traffic accidents and cancer adopted for the CCE. In the case of the chaining exercise, a stomach ailment was adopted, rather than an 'injury', which had been used previously.
Low probabilities	Expressions such as "10 in 10,000" or "10 for every 10,000" were used in the CCE and were clearly understood by respondents. Different risk reductions were used in the chained approach, such as 20/1,000, 100/1,000 and they were well understood by respondents. Good comprehension of probabilities is associated with communication in the first part of the questionnaire on risk and probabilities using visual tools (grids). However, real probabilities of death were not presented.	The use of grids to display risk and probabilities clearly helps respondents understand the probability figures presented in the scenarios. Such tools should be used in the final instrument as well.
Comparison of values for adults and children	Distinct values could be obtained for both children and adults from both survey instruments. Depending upon the precise approach chosen for the PTO	Split samples to ensure values obtained for both children and adults. Apply PTO questions, but not as the sole means to obtain a MRS.

	questions, people may have a tendency to choose programmes which save children, irrespective of the number of adults saved.	
Good to be valued	People are not always able to understand correctly extensions in life expectancy.	Mortality risk reductions valued in the final instrument survey.
Risk perception	The first questions of the questionnaire deal with risk comprehension and propose to train people in understanding the concept of mortality risks and of probabilities using grids. These aids were greatly appreciated by the respondents who found them very easy to understand and clear.	The use of such preliminary tools to be used in the final survey instrument.
Measure estimated	People have difficulty understanding, and therefore valuing, extensions in life expectancy.	As the project will value reductions in mortality risks, VSL will be estimated.
Valuation approach	Conjoint choice experiments were well accepted in Italy and the Czech Republic. The chaining approach was promising as respondents seem to fully engage in the exercise.	The two approaches (CCE and chaining) could be used in at least two of the three countries to be able to compare results between two countries.
Survey sampling	Only parents have been interviewed in the preparatory work.	As it would be awkward to ask a non-parent to value a risk reduction to a child, it is suggested to interview only parents.

1.2.4 Survey Design

Two distinct survey instruments were developed.

Chaining Exercise

On the one hand in the United Kingdom and the Czech Republic a novel 'chaining approach' was implemented, as well as a contingent valuation question. The questionnaire was in five parts:

1. Recruitment section
2. Warm-up section
3. Step 1 Chaining method: direct illness valuation
4. Step 2 Chaining method: standard gamble
5. Socio-Economic details.

In the first step, respondents are requested to indicate how much they would be willing to pay for a treatment which would avoid all of the effects of associated with one of four states of ill-health. This procedure is undertaken for all four possible health states.

They are then requested to imagine that they (or their child) have one of these conditions and that if they are not treated then a worse outcome (including in some cases death) will ensue. However, they are told that there are two possible treatments available, one of which involves a measure of risk. For example, respondents may be told that they are now afflicted with the permanent health reduction Pa. One treatment results in the certain outcome Ta (stomach pains with diarrhoea and vomiting for 12 months) while the alternative treatment offers the possibility of a quick return to full health but with a specified risk of death. The illness cards, are described as follows:

- **Temporary Adult (Ta)**: Severe stomach pains affecting the respondent with diarrhoea and vomiting for 2-3 days every 2 weeks for 12 months

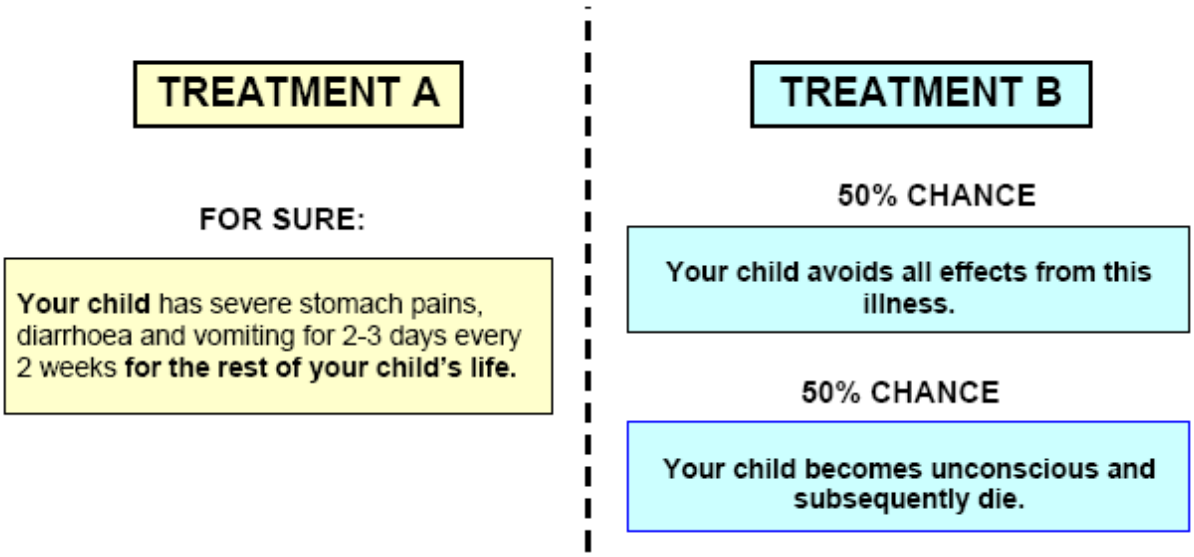
- **Temporary Child (Tc):** Severe stomach pains affecting the respondents' child diarrhoea and vomiting for 2-3 days every 2 weeks for 12 months

- **Permanent Adult (Pa)**: Severe stomach pains affecting the respondent with diarrhoea and vomiting for 2-3 days every 2 weeks for the rest of life

- **Permanent Child (Pc):** Severe stomach pains affecting the respondents' child diarrhoea and vomiting for 2-3 days every 2 weeks for the rest of life

All elements of this problem (the initial health state, the various treatment outcomes and the risk of success/failure) can be varied.

Example of Standard Gamble Question in Final Survey Instrument



By 'chaining' the responses to these two exercises, a VSL can be derived. The aggregated WTP stated in the first step can be equated to the average risk of dying provided in the second step so that an estimate of the VSL can be calculated as:

$$VSL = \frac{WTP}{\delta}$$

where δ indicates the average mortality risk level at which the population was indifferent between the illness and the treatment.

Other sections of the questionnaire elicited information on demographics and personal data (Section 0); the health states of the respondent and child (Section 1); the socio- economic characteristics of the respondent, as well as views on the questionnaire (Section 4).

Conjoint Choice Experiment

On the other hand, a conjoint choice experiment was implemented in Italy and the Czech Republic, alongside a contingent valuation question. The revised questionnaire incorporated a probability tutorial, tested respondents for comprehension of risks in this and in other contexts (e.g., lottery tickets), and insisted on individual probabilities rather than mortality rates. The following experiment design was implemented for the valuation questions in the final questionnaire:

1. Valuation questions were exclusively of the respondent or one of his or her children, selected at random from all children (but not both to avoid cueing respondents);

respondents were assigned at random to the treatment where they valued own risk reductions or risk reductions for the selected child;

2. There were a total of 5 pairs of risk-reducing profiles. Half of the respondents were assigned to one treatment whereby for each pair they faced a forced choice question (choose A or B?), followed by a choice question that allowed for an opt-out response (choose A, B or neither?). The other half of the respondents were given the A, B or neither question directly. This random treatment is dubbed TFORMAT in what follows.
3. The context (cause of death) was held the same across alternatives in the first two pairs of risk reducing profiles in the conjoint choice questions. The latency period was always the same for both risk reduction profiles.
4. The conjoint choice questions used the following attributes and attribute levels:
    a. Context (cancer, road traffic accidents, respiratory illnesses)
    b. Private good or public program
    c. Latency (0, 2, 5 and 10 years)
    d. Size of the risk reduction (2, 3, 5 and 7 in 10,000 over 5 years)
    e. (one time) cost to the respondent (200, 500, 1000, and 2000 euro)
5. All attributes were varied independently of one another for full identification.

Attribute and attribute levels are summarized below. To further elaborate on the reasons why we selected the attribute levels shown in table 1, we note that the risk reductions were similar to those assigned to the respondents in the contingent valuation exercise earlier in the questionnaire (where the risk reductions are 2, 3, 4, 5, 6 and 7 in 10,000 over 5 years). Combined with the cost information and with plausible discount rates, they span VSL figures ranging from €200,000 to €25 million.

Summary of attributes and attribute levels in the conjoint choice experiments

ATTRIBUTE	NO. LEVELS	LEVELS
Context (cause of death)	3	Cancer
		road traffic accidents
		respiratory illnesses
Private good or public program	2	private good (no other beneficiaries);
		nationwide public program (other beneficiaries)
Latency	4	0, 2, 5, 10 years
Size of the risk reduction	4	2, 3, 5, 7 in 10,000 over 5 years
(one-time) Cost to the respondent	4	200, 500, 1000, 2000 euro (Italy) 3200, 8000, 16000, 32000 CZK (Czech Republic)

The final questionnaire is divided into 9 sections. The conjoint choice experiments were placed roughly in the middle of the questionnaire. Section 0 begins with querying the respondent about his or her age, gender, and marital status. Respondents were prompted to enter the names, ages and gender of each of their children. The computer then selected at random one child among the eligible children, i.e., those aged 17 and younger. Throughout the survey, the questionnaire always refers to this selected child using his or her first name, e.g. "Paolo."

Section A asks several questions about the health status of the child, and section B asks questions about the health status of the parent (i.e., our survey respondent). In section C, we elicit extensive information about the health, lifestyle, and perceptions of environmental exposures and exposure to road-traffic risks for both the selected child and the parent. Section D presents a simple probability tutorial and some quizzes to test the respondent's comprehension of probabilities. Probabilities naturally lead to the risk of dying, which we depict using a grid of 10,000 squares (when we wished the respondent to focus on the magnitude of the risks) or with bar charts (when we wanted the respondent to focus on the different mortality risks across age groups, as a child grows up, and as a person gets older). We also ask people to tell us how much they "dread" certain causes of death.

In section E, we explain to people that it is possible to reduce the risk of dying and that both individual actions (e.g., pap smears, medical tests) as well as public programs (e.g., road safety programs, air pollution control regulations). In section F, we query people about purely quantitative aspects of risk, and then ask them a contingent valuation question about their WTP for a specified risk reduction (for either themselves or the selected child). Section G zeroes in on the three causes of death the CCE are about—namely, respiratory illnesses, cancer, and road-traffic risks.

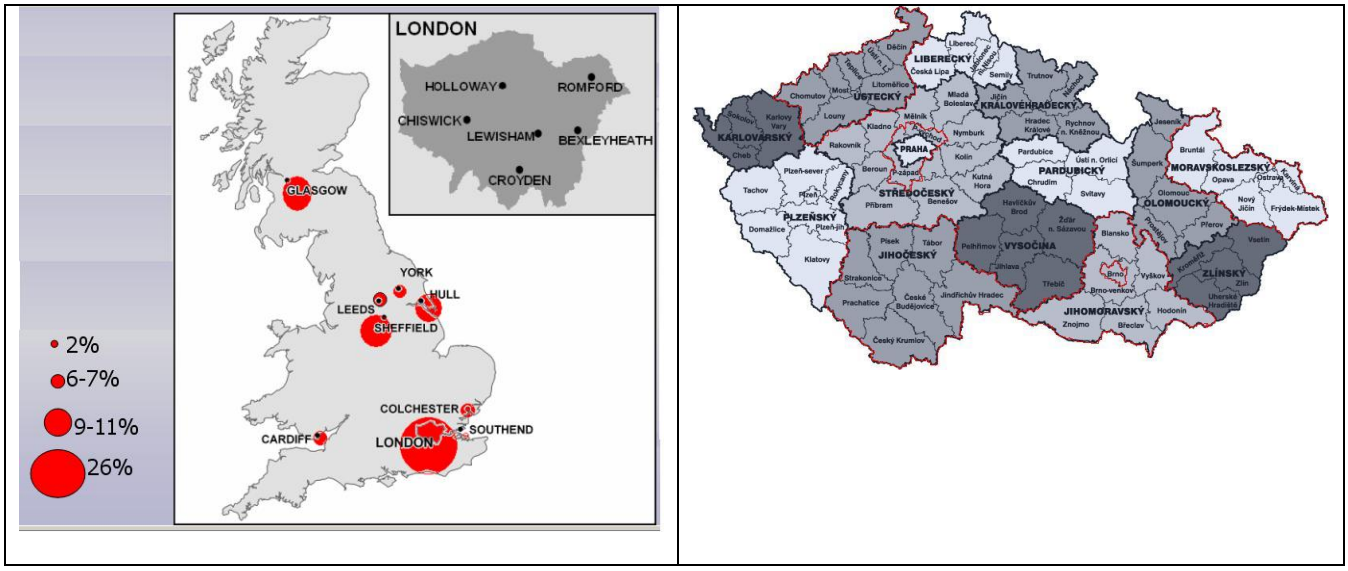
In section H, we engage people in question asking them to think about the effectiveness of private v. public risk reductions, and about the timing of the risk reductions. The conjoint choice questions were placed immediately thereafter, in section I, and were followed by extensive debriefing about reasons for wanting to pay (or not) and ways of financing the cost of the risk reduction. Section L asked various questions about risk perceptions and preferences for risk reductions now or in the future, and section M asked the usual sociodemographic questions.

1.2.5 Sampling and Survey Implementation

Chaining Exercise

As noted above, for the chaining exercise, two surveys with the same questionnaire format have been conducted in the UK and the Czech Republic. In the Czech Republic, the survey was implemented Prague and Brno, as well as six provinces. In the UK, observations were obtained from wide distribution of locations. (See Figure below for more detail.)

Geographical distribution of sampling locations



In the UK, in order to collect an approximately representative sample of parents, 14 UK locations have been selected. The precise geographical distribution of the respondents in the UK is listed in the Table below.

Sampling Locations in the UK

LOCATION	*NUMBER OF INTERVIEWS*
Leeds	*59*
Hull	*85*
York	*61*
Sheffield	*104*
Glasgow	*108*
Cardiff	*70*
Romford	*84*
Southend	*24*
Holloway Road	*41*
Colchester	*64*
Bexleyheath	*167*
Lewisham	*65*
Croydon	*62*
Chiswick	*6*
Total	*1,000*

The target was parents with children aged less than 18 years of age. Respondents were recruited on the street using a recruitment questionnaire which aimed to select a representative quota sample. Subsequently, respondents were invited into a hall, adequately equipped with laptops, and they undertook the survey administered by professional interviewers. Respondents were given a £5 voucher to thank them for their time in taking part. A professional survey company was responsible for data collection and data cleaning. Thirty-one days of face-to-face interviewing took place, including some weekends to ensure inclusion of working people. Interviewers were trained to deal with emotive topic such as child safety and to minimise the well-documented interviewers' bias.

Respondent Characteristics in the UK (% of Respondents)

AGE OF RESPONDENT	
18-24	10
25-34	32
35-49	51
50+	7
Child Age	
0-1	16.8
2-3	16.8
4-5	10.2
5-10	20.3
11-14	20.3
14-17	15.7
Educational level	
O levels / CSEs / GCSEs (any grades)	25
A levels / AS level / higher school certificate	8
NVQ (Level 1 and 2). GNVQ / HNC / HND	15.6
Other qualifications (e.g. City and Guilds, RSA/OCR, BTEC/Edexcel))	12
First degree (e.g. BA, BSC)	10.6
Higher degree (e.g. MA, Phd, PGSE, post graduate certificates and diplomas)	4
Professional qualifications (teacher, doctor, dentist, nurs, health visitor, other)	8
No qualifications	15
Other qualifications	1.5
Income class	
Under £4,500	2.5
£4,500-£6,499	7.4
£6,500 - £7,499	4.4
£7,500 - £9,499	4.30
£9,500-£11,499	5.20
£11,500-£13,499	4.60
£13,500-£15,499	4.9
£15,500 - £17,499	5.50
£17,500 - £24,999	9.3
£25,000 - £29,999	8.4
£30,000 - £39,999	10.2
£40,000 - £49,999	8.1
£50,000 - £74,999	6.80
£75,000 - £99,999	2.7
£100,000 +	1.9
Refuse	13.8

A similar procedure was implemented in the Czech Republic. This involved quota sampling of parents with at least one child below 18 years of age (that doesn't necessarily have to live in respondent's household). Quotas were also used for respondent age (18-34, 35-44, 45+), gender, level of education (three levels), regions (six), and size of municipality *(cities, 50k-100k, 10k-50k, 2k-10k, 2k less).* As in the UK, the interview mode was via computer-administered personal interviews. However, unlike the UK it took place at the respondent's home.

Respondent Characteristics in the Czech Republic (% of Respondents)

GENDER; N=1,000		**%**
	female	54.9
Age categories; N=1,000		**%**
	age18-34	31.7
	age35-44	33.9
	age45-65	34.4
Education; N=998		**%**
	elementary	3.7
	secondary	35.0
	A-level	41.1
	advanced training	5.4
	university	14.8
County; N=1,000		**%**
	Praha	24.70
	Jihočeský kraj	17.20
	Ústecký kraj	16.70
	Jihomoravský kraj	13.20
	Brno - city	13.20
	Moravskoslezský kraj	15.00

Overall, a good spread of respondents was obtained in terms of age, gender and socio-economic group and the main sample characteristics are reported. The mean of respondent' age is 37 in the UK and 39.5 years in the Czech Republic. The British sample consists of slightly larger families (3.66 compared with 3.46) having more children (1.75 versus 1.66). About half of selected children were boys in both countries. On average, the child selected in the Czech survey was older (9.8 years old) compared with the child selected in the UK survey (8 years).

Conjoint Choice Experiment

For the second survey instrument, the approach also involved quota sampling. However, in the case of Italy, only residents of Milan (where air pollution is a problem) were sampled. The final

survey took place in two dedicated facilities in Milan, and, as in the pilots, respondents self-administered the questionnaire using the computer. Aline Chiabai and Stefania Tonin were present for the first few days of the final survey, and personally observed about 20 respondents while the latter were taking the survey. Notes taken by Drs. Chiabai and Tonin and conversations with them suggest that respondents traded off the attributes of the alternatives as per the RUM when they answered the conjoint choice questions. Respondents were paid 10 euro for their participation in the survey.

Descriptive statistics of the key demographic variables from the final survey show that the sample is consistent with the sampling frame. Respondents were between the ages of 20 and 60, and only parents were included in the sample. The maximum age of the child age was 17. The sample was evenly split between mothers and fathers, but homemakers were restricted to no more than 20% of the women in the sample. In addition equal quotas for three age categories (30-34; 35-44; and45-49) were applied.

In terms of education, 23% of the sample has a university degree, which reflects the composition of the city's population. 51% had a high school diploma and 26% a junior high school diploma, which represents the minimum legal requirement. In addition, quotas were used for relative wealth - 50% of respondents lived in household with income less than 30000 euro/year, and 50% were above this threshold.

The Czech sample followed the same quotas as for the Milan sample, but was representative of the Czech population, including major cities (Prague, Ostrava and Brno), as well as smaller towns and rural areas. Interviewers were sent to people's homes, where they conducted the survey in-person using the computer in a manner similar to that used in Italy, *i.e.*, self-administered by the respondent.

Respondent Characteristics for Conjoint Choice Experiment

a. Discrete Variables

	ITALY		CZECH REP.	
Variable	N valid	percentage of the sample	N valid	percentage of the sample
Male	1906	49.06	1505	46.91
age: younger than 35	1901	33.56	1506	38.11
age: 35 to 44	1901	32.93	1506	22.58
age: older than 45	1901	33.51	1506	39.31
elementary school diploma	1906	0.21	1506	3.05
high school	1906	30.59	1506	35.79
high school diploma	1906	43.23	1506	46.81
college degree	1906	24.29	1506	11.75
graduate work (PhD)	1906	1.57	1506	2.59
Homemaker	1906	7.29	1506	1.73
household income above 30,000 euro	1891	43.68	1317	26.35
0-1,000 inhabitants	*n.a.*	*n.a.*	1506	11.22
1-5,000 inhabitants	*n.a.*	*n.a.*	1506	14.28
5-20,000 inhabitants	*n.a.*	*n.a.*	1506	12.48
20-100,0000 inhabitants	*n.a.*	*n.a.*	1506	22.64
more than 100,000 inhabitants	1906	100.00	1506	39.38
Married	1906	86.78	1506	74.9
divorced or separated	1906	4.41	1506	13.08
Widowed	1906	0.73	1506	1.73
Single	1906	8.08	1506	10.23
Fulltime	1906	73.24	1506	75.80
part time	1906	12.22	1506	3.65
job other	1906	1.89	1506	2.65

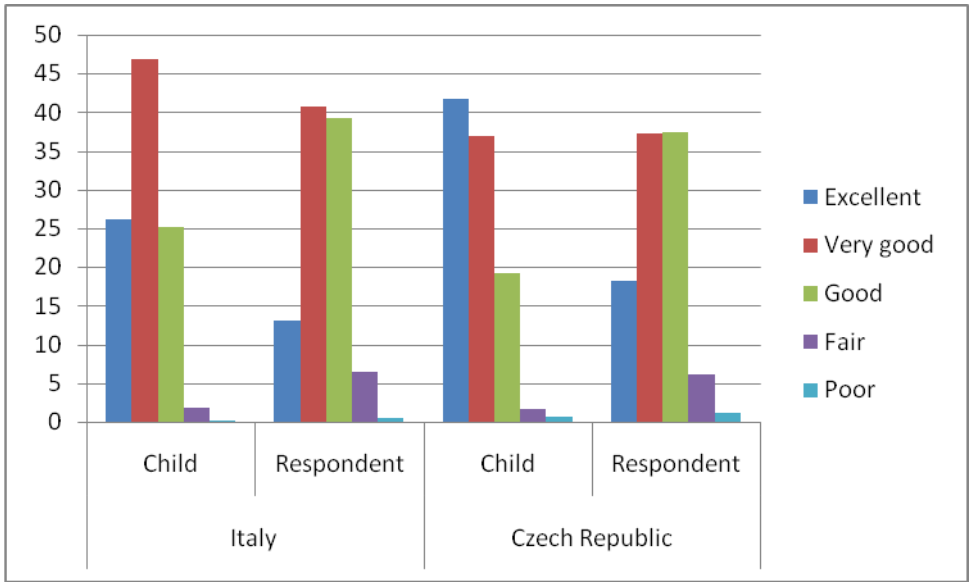
b. Continuous variables.

	ITALY					CZECH				
	N	mean	s.d.	Min	Max	N	mean	s.d.	Min	Max
Age	1906	**39.70**	*9.99*	20	59	1500	**39.61**	*10.59*	18	65
income (Euros)*	1891	**30463**	*12120*	5000	87500	1317	**23606**	*9574*	3529	50471
hhold size	1906	**3.21**	0.698	1	8	1503	**3.50**	0.920	1	9
children	1906	**1.31**	*0.549*	1	5	1506	**1.56**	*0.688*	1	5
agemax	1905	**9.33**	*7.491*	1	35	1486	**11.84**	*7.792*	0	45
agemin	1905	**7.67**	*6.020*	1	31	1486	**8.53**	*5.981*	0	24

* Income in Czech crown was recalculated by purchasing power parity assuming 17 CZK per Euro. Mean net annual income in national currency amounts 401,310 CEK (s.d.=162,757 CZK) with minimum of 60,000 CZK and maximum of 858,000 CZK..

As noted above, respodents were requested to indicate their health status (excellent, very good, etc…) and that of their child. The frequency of responses are presented below, with respondents more likely to report that the health status of their child is excellent than for themselves.

Health Status of the Respondent and Child
(Percentage of the sample indicating each health status category)



The table below shows that only minor proportions of the respondents reported chronic respiratory illnesses that require regular medication or inhalers, or cause limitations in physical activities. These proportions are slightly higher in the Czech sample, because the interviewers visited the respondents' homes. We expected persons with severe physical limitations to decline to participate in the study in Milan, since participation implies being willing to go to two centralized facilities in the winter. These expectations are borne out in the data.

Prevalence and Severity of Chronic Respiratory Illnesses in the Sample

HAS CHRONIC RESPIRATORY ILLNESSES THAT…	ITALY				CZECH REPUBLIC			
	Adult		Child		adult		child	
	N Valid	Percent	N Valid	percent	N Valid	percent	N Valid	percent
require regular medication or inhalers	1893	5.55%	1894	4.07%	1506	4.45%	1506	7.10%
cause small limitations in physical activities	1887	4.66%	1885	1.91%	1506	6.18%	1506	7.57%
cause serious limitations in physical activities	1870	0.80%	1880	0.27%	1506	2.19%	1506	1.66%
force him to stay home from work or school often	1871	1.07%	1882	1.38%	1506	0.80%	1506	2.92%

1.2.6 Summary Results of Empirical Analysis

The summary results are presented below, first for the chaining exercise (United Kingdom and Czech Republic) and then for the conjoint choice experiment (Italy and the Czech Republic).

Chaining Exercise

The objective of the first section in the chaining method was to obtain the maximum individual willingness to pay (WTP) values to avoid the effects of four different illnesses: permanent child (Pc), permanent adult (Pa), temporary child (Tc) and temporary adult (Ta). However, before prceeding to the WTP questions, in the warm-up section respondents had to rank four different illnesses from the most to least adverse impact. Each illness could refer to child or adult, and have temporary or permanent effects. The classification of illnesses obtained by respondents is reported in the tables below.

The ranking exercise of illnesses (United Kingdom)

	I (MOST SEVERE)	II	III	IV (LEAST SEVERE)
$Permanent_{child}$	57%	31%	10%	2%
$Permanent_{adult}$	38%	42%	16%	4%
$Temporary_{child}$	2%	18%	47%	33%
$Temporary_{adult}$	2%	10%	27%	61%

The ranking exercise of illnesses (Czech Republic)

	I (MOST SEVERE)	II	III	IV (LEAST SEVERE)
$Permanent_{child}$	72%	18%	7%	3%
$Permanent_{adult}$	22%	52%	23%	3%
$Temporary_{child}$	3%	24%	53%	20%
$Temporary_{adult}$	3%	6%	16%	74%

The different treatments are presented in different order in the "budget constraint" questionnaire, while the only sequence of treatments used in the "no budget constraint" questionnaire was Pc,

Pa, Tc, Ta.[8] Using the total payment values we report the main statistics of WTP measures. The results for the UK sample are presented below, followed by the Czech sample.

The main statistics of the WTP values in the UK

	MEAN (ST.DEV)	GEOMETRIC MEAN	TRIMMED MEAN 5% (ST.DEV)	MEDIAN	MIN	*MAX*
Ta	14,387 (53,830)	3,033	8,564 (13,509)	3,600	0	1,199,999
Tc	25,782 (197,136)	5,270	13,947 (20,187)	6,000	0	5,999,999
Pa	20,640 (63,441)	4,824	13,448 (20,687)	6,000	60	1,199,000
Pc	44,502* (283,085)	7,163	21,333 (35,690)	9,000	60	5,999,999

* we remove one unrealistic observation with WTP=99,999,999 from the dataset

The main statistics of the WTP values in the Czech Republic

	SAMPLE 1 (N=197) (WITHOUT BUDGET CONSTRAINT)			SAMPLE 2 (N=803) (WITH BUDGET CONSTRAINT)		
	Mean	st.dev	Median	Mean	st.dev	Median
Ta	14,047	28,750	3,934	12,230	45,001	2,951
Tc	17,819	33,449	4,918	14,809	46,627	4,328
Pa	23,173	46,654	4,918	17,027	41,247	5,902
Pc	27,674	51,790	6,557	22,982	59,128	7,869

These values can then be 'chained' with the standard gamble (SG) question to obtain a VSL. On this basis the 'best' estimate (i.e. using a single chain) for an child VSL in the United Kingdom is £342,323 is significantly greater than that of an adult £121,411. The difference in the Czech Republic is less pronounced (€128,736 and €81,892), but statistically significant at the 5% level.

[8] This constraint allows us to obtain a sufficient number of observations to allow for comparison with the budget constraint responses.

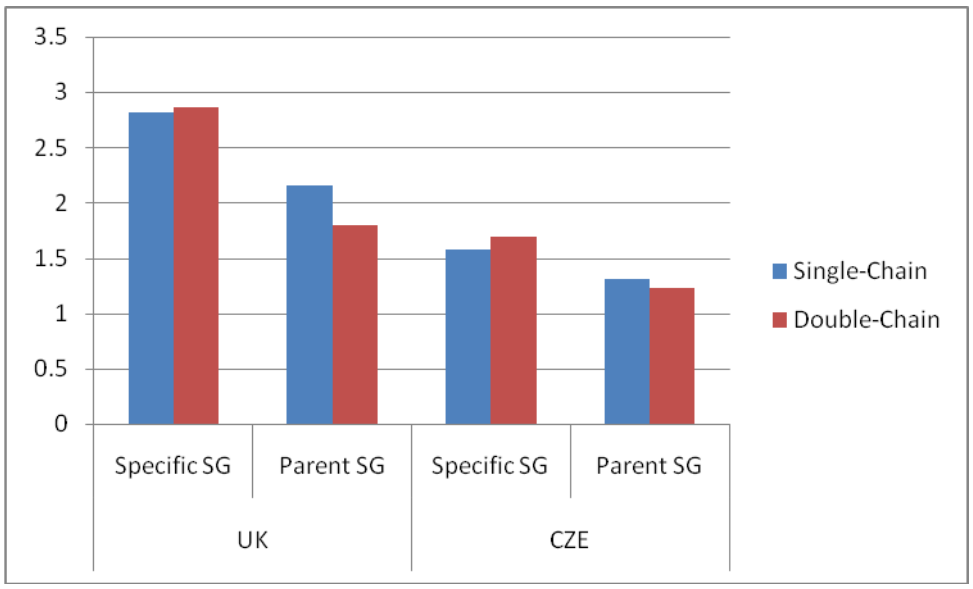
The VSL using mean WTP and SG values[9]

	UK		Czech	
	Mean VSL	Median VSL	Mean VSL	Median VSL
	Single Chain			
Adult	121,411 *(93,307-143,196)*	100,000 *(51,439-166,742)*	81,892 *(65,339-89,518)*	47,213 *(33,515-55,764)*
Child	342,323 *(201,607-464,471)*	1,636,364 *(-8,441,047-1.17e+07)*	128,736 *(101,174-142,267)*	112,412 *(83,089-129,481)*
	Double chain			
Adult	374,355 *(275,240-473,469)*	523,636 *(-24,695-1,071,969)*	212,862 *(155,940-246,583)*	131,148 *(82,016-165,983)*
Child	1,073,616 *(550,992-1,596,241)*	21,818,181 *(-2.14e+08-2.63e+08)*	360,722 *(268,282-413,850)*	443,404 *(263,708-574,767)*

However, there are concerns that there may be 'double-counting' associated with the chaining exercise, with the premium for child risk reductions applied twice. As such, in the figure below the MRS is presented when the parents' own standard gamble response is applied to both themselves and children.

[9] The mean and median VSL's for both VERHI samples in British pounds recalculated by nominal exchange rate with the confidence interval obtained using the bootstrap method with 1000 replications.

MRS for VSL based on the Chaining Exercise in UK and CZE[10]



Elicited VSL estimates for children exceed those for the parent, indicating that parents do place a premium on reducing mortality risks to children. However, the Czech values when the adult SG response is applied are not statistically different for children and adults. The ratios using the chaining method are similar to those already reported in the literature. For example, the ratio of the parent and child VSL estimates found in the literature are between 0.6 and 2.3. However, the wider literature on child premiums for safety and health (including illness as well as mortality) range between 0.6 and 6.0 with the average being around 2.0 (Hunt and Ortiz, 2006b).

Assessing the determinants of VSL (for adults and children) was one of the key objectives of the VERHI project. The following table reports the estimation results for VSL in the Czech Republic, with a number of socio-economic and household characteristics used as explanatory variables. However, we should be cautious with interpreting these models due to the fact the VSL is not directly observed and it is a product of stated WTP in contingent valuation part and the risk rate stated in standard gamble. Bearing this in mind, we can observe that the coefficient indicating that the respondent is a mother is positive and significant. The coefficient indicating that the selected child is a boy is also positive. The more members the household has, the lower VSL is. If the respondent' household has already made such a decision in real life, the VSL is smaller. In line with economic theory and one's expectations, we confirm positive and significant effect of income on the VSL. VSL is larger for respondents on maternity or parental leave, and smaller if the respondent was single. Being more educated increases VSL as well. Considering the responses related to what the respondent had thought about the questionnaire, we find that considering the situation unrealistic increases the VSL, whereas understanding the scenario with difficulty decreases the VSL.

[10] Bateman *et al.* (2009) 'Can Stated Preferences Yield Robust Estimates of the Value of a Statistical Life?'

VSL model in the Czech Republic (lognormal)

	Log(VSLchild)		Log(VSLadult)	
	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq
Intercept	14.033	*<.0001*	14.648	*<.0001*
age	0.021	*0.231*	0.005	*0.682*
female	0.471	*0.077*	0.101	*0.669*
hhsize	-0.458	*0.007*	-0.428	*0.003*
children	0.158	*0.514*	0.167	*0.267*
onlychild	-0.117	*0.785*		
boy	0.476	*0.057*		
agechild	-0.007	*0.829*		
hexperienced	-1.294	*0.000*	-1.602	*<.0001*
inc000	0.042	*0.001*	0.031	*0.004*
incmissing	2.997	*<.0001*	2.167	*<.0001*
parental	1.177	*0.028*	0.963	*0.030*
married	0.473	*0.159*	0.323	*0.272*
single	-0.916	*0.128*	-1.055	*0.047*
university	1.259	*0.001*	0.971	*0.003*
edubasic	-0.807	*0.247*	-1.061	*0.098*
unrealistic	0.940	*0.005*	0.609	*0.038*
diffunderstand	-0.846	*0.004*	-0.675	*0.009*
Scale	3.733		3.361	
LogLikelihood	-2489.87		-2478.64	
N	910		942	

In conclusion, evidence from observing respondents completing the survey indicates that they seemed to engage effectively with the chaining method questions. Indeed this approach appeared quite successful in overcoming the challenges associated with asking respondents to value small changes in mortality risk. The tests suggest that no ordering bias or budget constraint effects were found in the WTP responses. However, testing of the chaining approach reveals differing sources of procedural invariance, including possible double counting of a child premium which arises in both the WTP and SG procedures.

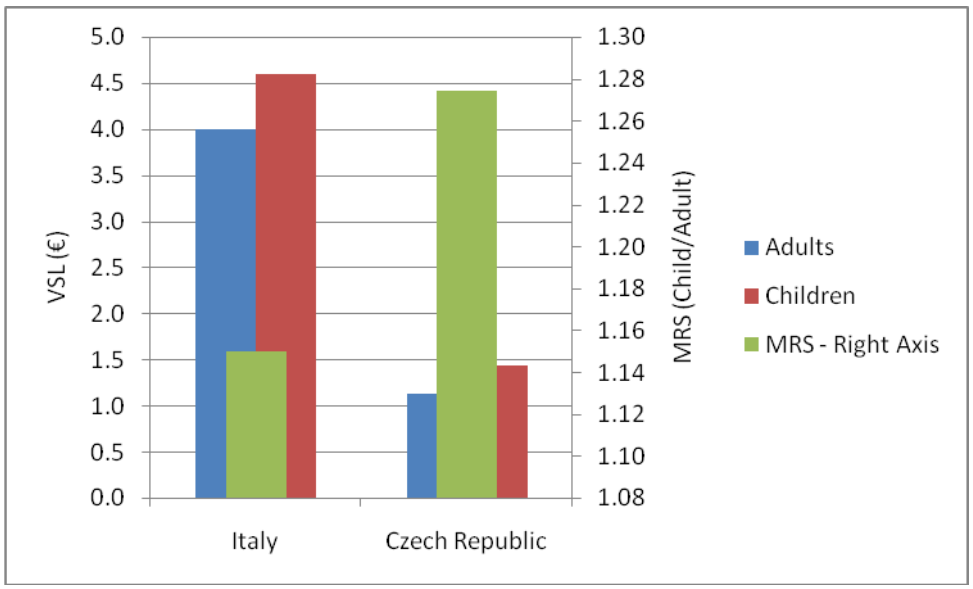
As such, although the chaining method appears to be a promising procedure for valuing statistical life for children, there are grounds for some caution. Given the scarcity of previous studies, much more research is needed before we can draw any concrete conclusions on the ability of the chaining method to estimate a VSL for children. Finally, further research is required to investigate the effect of life expectancy and time preference factors on the child/adult VSL ratio.

Conjoint Choice Experiment

In the case of the conjoint choice experiment implemented in Italy the VSL for an adult (€4.0 million) is not statistically different from a child (€4.6 million). In the Czech Republic the values are statistically different at the 10% level, with values of CZK 24.5 million for the child

and CZK 19.2 million for the adult. The figure below presents these figures,[11] alongside the marginal rate of substitution i.e. the ratio of these two values).

VSL and MRS in Italy and Czech Republic Based on CCE



However, there are differences in VSL between adults and children when differentiated by context. The Table below reports the results of runs in which we use the Italy data and allow the marginal utility of a risk reduction to vary with the cause of death. Clearly, the VSL is different across causes, with the largest value being that for the cancer context. The cancer premium with respect to the VSL when the cause of death is a road traffic accident is thus about 53% in the pooled child-adult sample, 26% in the child valuation sample, and 84% in the group that valued own (adult) risk reductions. The cancer "premium" would seem to be strongest among adults. This is not surprising, since cancer is extremely rare in children and the baseline risk for adults is higher, a fact that is not lost on our respondents.

Differences in values between cancer and the other causes of death is even more marked in the Czech Republic, where the child cancer premium is 64% for child and that among adults is 165%. If the "composite" VSL is lower for adults than it is for children in the Czech Republic, it looks like this is probably due to the comparatively lower VSLs for adult respiratory and road traffic, accident deaths: Our Czech respondents are prepared to pay relatively high amounts of money to reduce their own risks of death.

[11] Alberini and Ščasný (2009) "What is the VSL for Adults and Children?". Czech values obtained on basis of purchasing power parity exchange rate of 27 CZk/€.

Estimated (conditional logit) VSL by Context

a. Italy

	CHILD				ADULT			
	(A)		(B)		(A)		(B)	
	prob. of survival set to 1		prob. of survival = VERHI objective		prob. of survival set to 1		prob. of survival = VERHI objective	
N	6905		6465		7315		7315	
	amt in mill euro	std err in mill euro	amt in mill euro	std err in mill euro	amt in mill euro	std err in mill euro	amt in mill euro	std err in mill euro
VSL resp	4.5654	0.2917	4.6160	0.3011	3.3712	0.2185	3.3646	0.2182
VSL canc	4.8226	0.3400	4.8083	0.3467	5.3186	0.3403	5.3109	0.3397
VSL auto	3.8109	0.2928	3.8772	0.3041	2.8818	0.2268	2.8786	0.2264

b. Czech Republic

	CHILD				ADULT			
	(A) Prob. of survival set to 1		(B) Prob. of survival = VERHI objective		(A) Prob. of survival set to 1		(B) Prob. of survival = VERHI objective	
N	5271		5271		5513		5513	
	Amt in mill CZK	Std err in mill CZK	Amt in mill CZK	Std err in mill CZK	Amt in mill CZK	Std err in mill CZK	Amt in mill CZK	Std err in mill CZK
VSL resp.	23.23542	2.216202	23.24171	2.21648	15.08859	2.207444	15.02986	2.205842
VSL Canc	31.66045	2.850807	31.66131	2.850101	34.37822	3.300572	34.35842	3.298571
VSL Auto	19.32772	2.178573	19.3313	2.178286	12.94266	2.305804	12.93706	2.304064

In the table below, we report the results of a model specification where, in addition to the key attributes of the alternatives (i.e. context), we enter respondent-assessed measures of: (i) effectiveness of public programs in reducing the stated risks; (ii) dread; (iii) exposure to the circumstances where each cause of death would apply; (iv) beliefs about baseline risks of dying for a specific cause of death for a person the respondent's age or a child the same age as the respondent's child; and (v), sensitivity (which depends on current health status).

Effects of Cause of Death and Risk Characteristics on VSL
(non-linear conditional logit model)

	ITALY				CZECH REPUBLIC			
	Adult		Child		Adult		Child	
	Coeff	t stat	Coeff	t stat	coeff	t stat	Coeff	t stat
ALPHARESP	-0.0391	-1.372	-0.0415	-1.255	-0.1099	-4.511	-0.044	-1.917
ALPHACNCR	0.0607	4.732	0.0137	0.933	0.0836	4.86	0.0857	5.663
ALPHAAUTO	-0.0587	-4.639	-0.038	-3.189	-0.0436	-2.661	-0.0082	-0.644
PUBLIC	0.0485	7.19	0.0755	9.874	0.0271	2.921	0.073	7.963
DREAD	0.0227	5.175	0.0213	4.336	0.0035	3.911	0.0027	1.72
PUBEFF	0.0283	5.765	0.0296	5.489	0.0517	6.946	0.0271	4.132
HIGHEXPO	0.0202	2.001	0.0352	3.353	0.0464	3.593	0.0184	1.641
MORECOMM	0.0181	1.669	0.0352	3.213	0.0236	1.644	0.0185	1.420
SENSIT	-0.0055	-0.323	-0.0033	-0.128	0.028	0.942	0.1827	6.723
AGE3039	-0.0279	-1.715	-0.0139	-0.672				
AGE4049	-0.0486	-2.857	-0.0669	-3.251				
AGE5059	0.0123	0.631	-0.0513	-2.274				
MATURA	-0.0068	-0.495	0.0059	0.376				
SOMECOLL	0.0652	2.3	0.0719	2.433				
COLLEGE	0.0189	1.188	0.0397	2.266				
MOSTINC	-0.0452	-2.995	0.0161	1.032				
BETA	-0.0005	-16.702	-0.0005	-15.327	-0.005	-22.997	-0.005	-22.617
DELTA	-0.0145	-1.946	-0.0024	-0.311	0.0136	0.960	-0.0094	-0.892
N	6999		6059		5450		4998	
log L	-6294.52		-5416.05		-4821.62		-4469.82	

The results show clearly that the VSL increase with the dread associated with a cause of death, with public programs (here, for simplicity, we do not distinguish for public and private risk reductions for each cause of death), with the perceived effectiveness of public programs, and with exposure. Regarding the effect of beliefs about how common a cause of death is for people the age of the beneficiary in the conjoint choice tasks, the estimated coefficient on this variable has the expected sign, but the significance level differs between child and adult in Italy, and is weak in the Czech Republic.

Even more important, the results show that controlling for the attributes of risk and risk perception has not been sufficient to explain away the differences in the VSL for each cause of death. All else the same—and so, controlling for dread, exposure, etc.—respiratory causes of death and road traffic accidents continue to be valued less, and cancer continues to be valued more, than that predicted by attributes and perceptions alone. Perhaps this is due to the fact that our constructs do not capture all possible facets of risk perceptions, or to the fact we do not have an explicit way to control for familiarity with the type of risk being valued.

In the next table we report on results which focus on demographic characteristics. We find that if the selected child is a boy, a parent would be willing to pay less than for the risk reduction for a daughter. The VSL for daughters is about €0.4 million euro larger than the VSL for boys. When the selected child is a daughter, mothers would be prepared to pay less (VSL is about €0.56 million euro smaller) than fathers. When the selected child is a boy, however, a mother would be prepared to pay more than a father for any given risk reduction. Indeed, the highest WTP is that for reductions in the risks of "mama's boys."

Birth order and the age of selected child do not appear to have an effect. However, the more the children in the family, the smaller the VSL for any selected child. While others may interpret this as a quality v. quantity type of argument (which assumes the more children, the lower VSL is), we believe that this effect is attributable to income constraints. We will investigate this issue in depth in future research. Single mothers are prepared to pay significantly more (the effect on the VSL being €0.4 million) than mothers living with their husbands.

We find a strong effect on the VSL associated with respondents from the city of Brno and marginally, at 10% level, from Prague –i.e. two big cities comparable with Milano –, and a small, positive and significant effect among respondents who live in towns with fewer than 20,000 people. Finally, respondents who always report their own as well their spouse's opinions hold a larger VSL than those who always report only their own (by about €0.5 million euro), and the latter is in turn larger (by €0.24 million euro) than that of people who sometimes report their own tastes and sometimes their spouses'.

Effects of Demographic and Household Characteristics on VSL in the Czech Republic[12]
(Non-linear conditional logit model)

	COEFFICIENT	T STAT
ALPHARESP	0.053	0.709
ALPHACNCR	0.0478	3.885
ALPHAAUTO	-0.0244	-2.188
PUBLIC	0.0732	7.978
MALECHIL (child is a boy)	-0.0557	-2.693
AGE6_10	0.0018	0.089
AGE11_15	-0.0016	-0.081
AGE16_18	-0.0078	-0.409
ONLYCHIL (child is an only child)	-0.1176	-2.671
YOUNGEST (child is the youngest child in the family)	0.0536	1.367
MOTHER (respondent is the mother)	-0.0756	-3.037
MUMBOY (respondent is the mother and the child is a boy)	0.1192	4.221
OLDEST (child is the eldest child in the family)	0.0633	1.539

[12] Child subsample only, pooled TFORMAT treatment, VERHI objective probabilities of survival, no obs with missing age for respondent or child, or children older than 17.

CHILDREN (number of children the respondent has)	-0.0319	-1.517
MUMONLY (respondent is the mother and the child is an only child)	0.055	1.996
PRAGUE	0.0356	1.673
BRNO	0.2384	8.838
OSTRAVA	-0.0301	-0.806
SMALLTWN (resident of city with less than 20,000 people)	0.0373	2.133
MEONLY (answers to conjoint choice questions are just the respondent's opinions)	0.0321	2.077
MESPOUSE (answers to conjoint choice questions reflect the respondent and spouse's opinions)	0.0692	3.723
BETA	-0.005	-22.687
DELTA	-0.0077	-0.752
N	5041	
log L	-4464.26	

Since intra-household decision-making is key to understanding the valuation of risk reductions for children, at the end of the conjoint choice section of the questionnaire, we asked the respondent whether in answering the choice questions he was reporting only his opinion or his spouse's opinions as well. As shown in the table below, about 50% of the respondents reported only their own opinion, and 32% of Italian respondents and 30% of Czechs believed their answer mirrored their spouse's opinion as well. These percentages do not vary systematically across genders.

Distribution of responses to question concerning individual vs joint responses[13]

	ITALY		CZECH	
	freq	**Percent**	**freq**	**Percent**
only my opinions	842	51.12	555	49.33
the opinions of both of us	521	31.63	326	28.98
my opinions in some cases, the opinions of both in other cases	284	17.24	244	21.69

On the basis of different models estimated based on the data collected in Italy and the Czech Republic, the results indicate that:

- When we do not distinguish for the cause of death, for Italy, child VSL is about €4.6 million, whereas parent VSL is about €4.0 million. These figures are not statistically different from one another. For the Czech Republic, child VSL is €0.91 million and parent VSL is €0.71 million if we recalculate the Czech crowns by nominal exchange rate, or

[13] When you answered the choice questions, did you report only your own opinions or do you believe your answers mirror your spouse's opinions as well?"

€1.44 million and €1.13 million respectively if purchasing power parity is used. VSL for child and adult are marginally statistically different at the 10% significance level.

- Using the pooled sample of child and adult valuation responses, in Italy, the VSL for a respiratory death is €3.947 million, that for cancer is €5.122 million, and that for road-traffic accidents is 3.342. Pairwise comparisons using Wald tests indicate that these figures are statistically different. In the Czech Republic, the VSL for a respiratory death is €0.73 million (€1.16 million PPP), that for cancer is €1.20 million (€1.90 million PPP), and that for a road-traffic accident €0.60 million (€0.96 million PPP). These VSL figures are statistically different for the pairs respiratory-cancer and cancer-road accident, but not for the pair respiratory-road accident.

- VSL for cancer is larger than VSL for respiratory death in both our samples; the VSL cancer 'premium' is about 30% in Italy and 67% in the Czech Republic relative to the VSL for respiratory illness. It is interesting that the cancer premium is larger for adults than for children.

- In Italy, people are prepared to pay more for a risk reduction delivered by a public program, but only when the cause of death is respiratory illness. This is likely to be due to the association that people make between air pollution, which they expect to be addressed by public programs, and respiratory illnesses. Regardless of the cause of death, people are willing to pay more for a risk reduction delivered by a public program when they deem public programs to be "very effective" in reducing risks.

- The more one dreads a specified cause of death, the higher the VSL for that cause of death tends to be. This is so both in Italy and in the Czech Republic.

- The discount rate exhibited by people for future risk reductions is not significantly different from zero, at least when we use the "objective" probabilities of surviving implicit in the mortality rates that were shown to people in the questionnaire.

- Only in the Italy study did we ask people to give us an estimate of their probability of surviving for 5 and 10 years. When we use these subjective probabilities in the econometric model of the responses to the conjoint choice questions, we get *negative* discount rates, usually about -2%.

- When attention is restricted to child VSL, we found that in the Italy child age, gender, whether an only child or with siblings, the eldest or the youngest did not affect the VSL. Gender and marital status of the parent who participated in the valuation tasks did not affect the VSL either. Mothers' WTP was not different depending on whether the child was a boy or a girl.

- Turning to the Czech Republic, the age of the selected age does not matter. However, we found that if the selected child is a girl, fathers would pay more than mothers. If the selected child is a boy, mothers would be willing to pay more than fathers, especially when the boy in question is an only child. We found that the number of children a

respondent has is negatively related to the VSL. Respondents who always report their own as well their spouse's opinions hold the largest VSL. Larger VSL is also stated by parents living in big cities and small towns and villages with fewer than 20,000 people. These results however only hold for the Czech sample that shows larger heterogeneity with respect to municipality size and locality of residence.

Benefits Transfer

In principle, benefit transfer is a method to place a value on a welfare change for which a value does not exist at a given time and/or locale. This approach applies existing estimates from the study sites (where the value is transferred from) to a new policy site (where the value is transferred to). The most common approach of value transfer is based on transferring original results from a study site directly to a policy site, with adjustments of the existing values for inconsistency in time (Navrud 2004), currency (Brouwer and Bateman 2000) or income (Navrud and Ready 2007).

In the VERHI study, we adopted several benefit transfer techniques: the naïve transfer based on using nominal exchange rate, a simple transfer based on using purchasing power parity, and transfers that correct for differences in income levels. With the naïve transfer, the first step is to decide which nominal exchange rate should be used. In our case, this was not straightforward choice because the nominal exchange rate has been fluctuating.[14] For our benefit transfer, we use a medium-term level of the nominal exchange rate, which is equal to 27 CZK per Euro. The purchasing power adjusted rate, we get 16.927 CZK per euro, which we round up to 17 CZK per Euro in our calculations. When we conduct a benefit transfer that adjusts for differences in income levels, we assume two alternate income elasticities of WTP: 0.7 and 1.0, i.e. the values that are supported by empirical research carried out in the Czech Republic (Alberini *et al.* 2006; Czajkowski and Ščasný 2009).

The error rates[15] for naïve and simple benefit transfers would indicate the error rate if the VSL derived for one country (e.g. Italy) was used in another country (the Czech Republic). Due to the stronger purchasing power of Czech crown, using purchasing power parity decreases the error rates by almost half of the transfer error rates derived if nominal exchange rates were used. Adjustment transfers for the income differences decreases the error rates further, but they still remain large in absolute magnitude. The larger the income elasticity of WTP used, the lower the transfer error rate. Benefit transfer generates relatively lower transfer error rates for the transfer of VSL for children than for adults. We display transfer errors in the table below.

[14] The Czech crown appreciated significantly with respect to the euro during our pre-survey phase, starting at 28 and ending below 23 CZK per euro in July 2008, with the average of 24.94 CZK per euro in the year 2008. During the survey, the exchange rate ranges between 25 to 26 CZK per euro. But several months after the survey, the nominal exchange rate fluctuated between 26 to 29 CZK per euro.

[15] Note: The error rates for transfers from the Czech Republic to Italy equals to respective error rate reported above multiplied by $\left(\_^{VSL_{cz}}\!\!\diagup\!\!_{VSL_{ita}}\right)$.

Transfer error rates (transfers from Italy to the Czech Republic).

	In Euro by nominal exchange rate			In Euro by purchasing power parities		
	Naïve transfer	income adjusted ε=1	income adjusted ε=0.7	Simple transfer	income adjusted ε=1	income adjusted ε=0.7
All	431%	159%	221%	234%	159%	180%
Adults	464%	175%	241%	255%	175%	197%
Children	408%	148%	207%	220%	148%	168%

Note: Model with VERHI objective probability of survival.

Considering now the transfer for VSL for different causes of death, the transfer errors are smaller for the transfer between children than between adults. The smallest transfer error – among these three causes of death – holds for the VSL for cancer, while the transfer errors are comparable large for other two causes.

Transfer error rates (transfers from Italy to the Czech Republic) by cause of death

	In Euro by nominal exchange rate			In Euro by purchasing power parities		
	Naïve transfer	income adjusted ε=1	income adjusted ε=0.7	Simple transfer	income adjusted ε=1	income adjusted ε=0.7
ALL						
respiratory	452%	170%	234%	248%	170%	191%
cancer	328%	109%	159%	169%	109%	125%
car accidents	457%	172%	237%	251%	172%	194%
ADULT						
respiratory	504%	195%	266%	281%	195%	218%
cancer	317%	104%	153%	163%	104%	120%
car accidents	501%	193%	264%	278%	193%	216%
CHILD						
respiratory	436%	162%	224%	238%	162%	182%
cancer	310%	100%	148%	158%	100%	116%
car accidents	442%	164%	228%	241%	164%	185%

The transfer errors between Italy and the Czech Republic are comparatively smaller for public interventions and especially for cancer. The transfer errors for VSL derived in the context of road-traffic accidents and public programs and when adjusting the income differences are below 100%. The transfer error is only about 34% for the case of cancer risk reducing by public intervention after adjusting for the difference in income level.

Transfer error rates (transfers from Italy to the Czech Republic) by cause of death and public vs. private interventions

	In Euro by nominal exchange rate			In Euro by purchasing power parities		
	Naïve transfer	income adjusted ε=1	income adjusted ε=0.7	Simple transfer	income adjusted ε=1	income adjusted ε=0.7
private: respiratory	485%	186%	254%	269%	186%	208%
private: cancer	391%	140%	197%	209%	140%	159%
private: car accidents	425%	156%	217%	230%	156%	176%
public: respiratory	448%	168%	232%	245%	168%	189%
public: cancer	175%	34%	67%	73%	34%	45%
public: car accidents	262%	77%	119%	128%	77%	91%

We also examined the effect of cause and public program context on the VSL, using the VSL for respiratory illness and private intervention as the reference. When attention is restricted to respiratory causes of death, transferring the VSL from the private context to a public program yields transfer errors of 49% in Italy and 59% in the Czech Republic, respectively. Focusing on private actions, the VSL for cancer is 45% (Italy) and 74% (Czech) higher than that for respiratory illness, whereas that for road-traffic accidents in -24% (Italy) or -16% (Czech) than that for respiratory causes of death. From our study, we conclude that with private interventions the benefit transfers for cancer work worse than the transfers between respiratory risk and road-traffic accidents.

In the case of the chaining exercise, we measured the transfer error rates for WTP to avoid four investigated illnesses. Let us start with naïve transfer and by using both nominal values of mean WTP in British pounds. The error rates are the largest for transfer between the UK and the Czech Republic for the most severe illness, i.e. Pc. On the other hand, the lowest error rates we observe for the transfers of WTP for parents (when WTP was stated to avoid Ta or Pa). Using nominal Euros would just slightly increase the error rates of the transfers.

Using simple benefit transfer with PPP corrections would yield the error rates about ±20%, except the error for transfer for Pc that is 34%. If the illness in parents is valued, the transferred value of WTP from the UK would be even smaller than the actual WTP which is estimated from the Czech data. Considering WTP for all valued illnesses, we conclude that PPP correction works better than the naïve transfers. Correcting for the differences in income works even better; the error rate is only 5% for the WTP transfer for Tc, having relatively small error also for second illness in child, Pc.

Transfer error rates for WTP in the UK and the Czech Republic

	Ta	Tc	Pa	Pc
Naïve transfer				
Euro nominal	27%	86%	26%	107%
£ nominal	16%	70%	15%	89%
Simple transfer with PPP correction				
£ PPP	-18%	20%	-19%	34%
Adjustment by income differences				
income elasticity=1				
£	39%	-5%	41%	-14%
income elasticity=0.7				
£ nominal	21%	-18%	22%	-26%
£ PPP	34%	-9%	35%	-18%

Czech respondents are less risk-averse compared to British respondents. This is documented in the table below, which reports percentage difference. The risk rates, i.e. the chance of failure, for all four considered cases are lower in the UK sample and their difference ranges from 17% to 30%. British respondents are particularly more risk averse when Pc is traded with death for their children; in this case the average risk is 30% lower than the Czech counterpart, median is even 92% lower than the Czech median.

Naïve transfers yield quite large error rates between 50% to 240%; the error rates are larger for the double chain than for the single chain. Simple transfer that adjusts by purchasing power parities decreases the error rates. In the case of the single chain, the error rate of mean VSL for parents is only 7%; for the case of children the error is still about 90%. Correcting for the income differences yields the lowest error rates – 7% or about 40-50% respectively – but the transfer of the mean VSL for children from the UK would be even lower that observed Czech VSL value.

Transfer error rates for the VSL (UK and Czech Republic)

	single chain		double chain	
	VSL parent	**VSL child**	**VSL parent**	**VSL child**
Naïve transfer				
Euro nominal	65%	196%	101%	240%
£ nominal	51%	170%	84%	210%
Simple transfer with PPP correction				
£ PPP	7%	91%	30%	120%
Adjustment by income differences				
income elasticity=1				
£ nominal/PPP	7%	-40%	-12%	-48%
income elasticity=0.7				
£ nominal	-7%	-48%	-24%	-55%
£ PPP	3%	-42%	-15%	-50%

Transfers between these two national samples works the best when VSL for parents is derived. In fact, other differences in socio-demographic characteristics, culture or risk aversion between different samples might drive differences in VSL when the mortality risks in children are considered. We plan to investigate these issues further in future research.

Person-Trade-Offs

In the case of person trade-offs the objective it to elicit preferences in public policy settings. We begin by asking to consider different groups of people who, if left untreated, will shortly suffer certain health state, the details of which were shown on the card. We introduce two groups only, in which one of two groups is composed of children of about 10 years old, the other one by adults of 40 years old. These two ages were just the expected mean age of the child and the parents in our sample.

Suppose there is a new treatment that could completely prevent given a health state and allow those affected to live a normal life. It would cost exactly the same to treat each Group, but suppose there are only enough resources at present to treat one of these groups, not both. What the respondent has to decide is "Which group should be treated?" In order to get the point where she is indifferent between these two groups, we asked the respondent to decide again, successively reducing the number of members of that group that was previously preferred by the respondent.

In total, three health outcomes were considered in person-trade-offs:

- severe stomach pains affecting a person with diarrhoea and vomiting for 2-3 days every 2 weeks for 12 months,

- severe stomach pains affecting a person with diarrhoea and vomiting for 2-3 days every 2 weeks for the rest of life, and
- premature death.

We found in the pre-survey testing that some respondents might have ethical problems to take responsibility for such a decision. Therefore we allow the respondent to not answer and protest against this scenario. If the illness T is considered, there are 25% of the parents who would protest. The share of protests increases to 32% for P, and it is 47% if premature death is considered. Then, we derive the ratio of adult and child members within respective group that makes the respondent indifferent if he should decide which members of one group shall be treated; the result for the entire Czech sample is reported in the table below.

PTO results in the Czech Republic

	N	Mean	Std Dev	Median	geo mean	Min	Max
PTO							
T #adults	739	**92.85**	*19.52*	**100.00**	**88.74**	0	100
T #children	710	**58.92**	*32.31*	**60.00**	**46.54**	0	100
P #adults	676	**96.76**	*13.89*	**100.00**	**94.89**	0	100
P #children	649	**48.42**	*30.25*	**45.00**	**36.34**	0	100
Death #adults	533	**96.44**	*13.60*	**100.00**	**95.35**	0	100
Death #children	521	**48.94**	*31.95*	**50.00**	**35.70**	0	100
MRS child/adult							
PTO1(T)	708	**3.37**	*6.60*	**1.67**		0	100
PTO2(P)	644	**5.03**	*11.12*	**2.15**		0	100
PTO3(death)	510	**6.13**	*14.92*	**2.00**		0	100

The marginal rate of substitution is then defined as the ratio of adult persons to child persons stated by each individual in respective PTO consequent questions. From the table below we see the distribution of individual MRS's is skewed; the MRS ranges between 3.4 to 6.2 for means, but the MRS derived from medians ranges between 1.7 to 2.2. Following the approach adopted to derive the VSL above, we take the mean number of adult and child persons to determine the MRS.

MRS derived from PTO means

	Mean	**Median**	**Geometric Mean**
PTO1(T)	**1.58**	**1.67**	**1.91**
PTO2(P)	**2.00**	**2.22**	**2.61**
PTO3(death)	**1.97**	**2.00**	**2.67**

The MRS derived from the means in this case is 1.58 for the least severe illness outcome, T, whereas the MRS is around 2.0 for P and premature death. The MRS derived from geometric means are substantially larger; 1.91 for T, 2.6 for T and 2.67 for illness terminated in death. Each reported statistic confirms the parents prefer to treat ill children or save children if the decision in public context needs to be taken between children and adults.

Having more children increases MRS for all cases of person trade offs, when the coefficient declines with severity of effect. If the parent has an only child, MRS is also larger. Income does not have an effect on MRS. However, if we measure economic situation by an indicator on how the respondent perceives the situation of his/her family (incdiffrank), the better he perceives the economic situation of his family, the larger MRS between saving the group of children and the group of adults. The age of the respondent does not have the effect on MRS for the case of PTO1 (T outcome) and PTO3 (death). However, age has an effect on MRS for the health outcome with a permanent impact (PTO2). Controlling for the effect of being retired separately, we find the retired value the group of children less only for the least severe outcome (i.e. in PTO1 scenario). The effect of others controlled characteristics did not prove to be significant.

PTO models (Czech Republic)

	PTO1		PTO2		PTO3	
	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq
Intercept	-0.453	0.351	0.380	0.464	0.605	0.317
age	0.003	0.618	-0.009	0.100	-0.009	0.133
female	0.035	0.673	0.102	0.247	0.040	0.705
hhsize	-0.051	0.317	-0.048	0.363	-0.051	0.448
children	0.283	0.000	0.205	0.013	0.197	0.094
onlychild	0.378	0.004	0.386	0.006	0.323	0.075
inc000	-0.004	0.386	0.000	0.972	-0.011	0.048
incmissing	-0.233	0.248	-0.525	0.014	-0.552	0.031
incdiffrank	0.177	0.002	0.136	0.021	0.184	0.009
livstdrank	0.093	0.192	0.106	0.160	0.122	0.164
employed	-0.236	0.123	-0.185	0.247	-0.223	0.266
parental	0.130	0.500	-0.016	0.938	-0.003	0.991
housekeeper	-0.387	0.312	-0.300	0.414	-0.499	0.227
retired	-0.539	0.067	0.194	0.517	-0.270	0.498
married	0.014	0.892	-0.093	0.396	0.030	0.824
single	0.053	0.778	-0.144	0.481	-0.250	0.307
university	0.000	0.998	0.035	0.779	0.012	0.935
edubasic	-0.259	0.235	-0.125	0.629	-0.171	0.557
unrealistic	-0.180	0.061	0.044	0.664	0.096	0.456
Scale	0.988		0.985		1.071	
LogLik	-966.45		-880.47		-736.27	
N	687		627		495	

1.2.7 Workshop (WP7) and Policy Implications (WP8)

While it is clear that there is no single MRS, there is some evidence - from VERHI and the literature more generally - that the VSL for a child is greater than that of an adult. This result is not unequivocal, however, not even within the VERHI project. Nonetheless, there is a pressing political need to explore this issue further, and this point was emphasised in the workshop which concluded the VERHI project. While the interests of children are usually defended by parents (and other caregivers), policymakers in OECD governments have always had a special role in protecting the interests of children with respect to risks in general. In some cases (i.e. negligence or abuse), this role may supersede that of their parents.[16] As such, there is, at least, a distinct obligation with respect to children's risks to determine whether or not a premium should be applied.

Are there general rules, which can be applied to determine cases in which children-specific values would be most helpful? The EPA (2003) notes that a separate analysis of children's VSL is not required for CBA if the household rather than the individual is the relevant unit of analysis. This would be the case if the policy intervention in question mitigates a bad to which the whole household is subject. For instance, this would be the case for a hedonic property price model related to hazardous waste siting. The opposite case, where such an estimate is particularly

[16] In legal parlance, this is referred to as *parens partriae*. See Hoffmann (2007).

important, would be in the presence of intra-household externalities. An example of such a case would be health effects for second-hand smoke from tobacco consumption.

More generally, in cases where the policy intervention particularly affects children due to nature/scope of policy (e.g. pesticides in school grounds) or because children are particularly vulnerable to this particular hazard (e.g. lead in drinking water), then child-specific values are likely to be particularly helpful in ensuring that resources and policy efforts are allocated efficiently. In addition, if private risk-reduction opportunities available for children (or their parents and others affect their exposure to risks) are limited or ineffective, valuing the benefits of public interventions is likely to be particularly useful.

1.3 Disemmination and Use of Results

1.4 Dissemination of knowledge

A dedicated public website on the project has been created, on which project progress is documented, and links with other related projects and policy programmes are established (http://www.oecd.org/env/social/envhealth/verhi). It is also ensured that links (on other related websites) were made to the VERHI website, in particular websites of the three other contractors:

- FEEM: http://www.feem.it/Feem/Pub/Programmes/Sustainability+Indicators+and+Environmental+Valuation/Activities/200601-VERHI+Children.htm
- UEA: http://www.uea.ac.uk/env/cserge/research/60.htm
- CUEC: http://cozp.cuni.cz/COZP-78.html

In addition, a brochure (downloadable on the public website) has been released in order to raise public awareness. It is distributed in workshops, conferences, and other major events occurring inside or outside the OECD.

Through the OECD's Working Party on National Environmental Policies and the Environmental Policy Committee, the consortium has also had direct access to policymakers with an interest in the links between environment and health in the form of biannual meetings. By regularly presenting progress on the project and work on valuation in general, the project provides policy support on an on-going basis. Outputs from the project have been presented at three OECD Committee meetings:

- The 13th Meeting of the OECD Working Party on National Environmental Policies (4-5 March 2008)
- The 14th Meeting of the OECD Working Party on National Environmental Policies (19-20 November, 2008)
- The 15th Meeting of the OECD Working Party on National Environmental Policies (28-29 April, 2009)

The outcomes of the project will be presented at the 16th meeting of the WPNEP (18-19 November 2009).

Academic papers prepared thus far include three papers presented for peer review at the 17th EAERE Annual Conference in Amsterdam (June 24th-27th, 2009) (www.eaere2009.org), as well as papers presented at other Conferences and venues:

- Bateman, I.J., Bolt, K., Day, B.H., Ferrini, S. and Loomes, G. (2009) 'Can Stated Preferences Yield Robust Estimates of the Value of Statistical Life? Results from lab and field investigations of a VSL for adults and children, presented at the *Envecon 2009: Applied Environmental Economics Conference* (http://www.eftec.co.uk/UKNEE/envecon/2009_documents/envecon2009_ECONOMIC_VALUATION_Ferrini_presentation.pdf), held at The Royal Society, London on 20th March 2009.

  [focussing on risk communication, familiarity with the good, budget constraints]

- Bateman, I.J., Bolt, K., Day, B.H., Ferrini, S. and Loomes, G. (2009) 'Can Stated Preferences Yield Robust Estimates of the Value of Statistical Life (VSL)? Lab and field applications of conventional and novel techniques for estimating VSL for adults and children, keynote speech at the *XXIX Meeting of the Spanish Health Economics Association*, 17th-19th June 2009, Malaga, Spain (http://www.aes.es/Jornadas/index.php - Spanish only)

  [focussing on the VSL for children compared to adults]

- Alberini, Anna, Milan Ščasný, Aline Chiabai, Markéta Braun Kohlová, Hana Škopková and Stefania Tonin. 'Mama's Boy, Daddy's Girl? The Effect of Parent, Age and Gender on Child VSL' presented at the 17th EAERE Annual Conference in Amsterdam (June 24th-27th, 2009) (www.eaere2009.org) (http://www.webmeets.com/files/papers/EAERE/2009/590/alberini%20et%20al%20%20VERHI%20Child%20CCE%20Italy-CR%20for%20EAERE%202009%20%28anonymous%29.pdf)

  [focussing on impacts of demographics and household composition on VSL]

- Alberini, Anna, Aline Chiabai and Stefania Tonin 'The VSL for Children and Adults: Evidence from Conjoint Choice Experiments in Milan, Italy' presented at the 17th EAERE Annual Conference in Amsterdam (June 24th-27th, 2009) (www.eaere2009.org)

  [focussing on discounting of latency, public/private risk reductions, context]

- Bateman, I.J., Bolt, K., Day, B.H., Ferrini, S. and Loomes, G. 'Can Stated Preferences Yield Robust Estimates of the VSL? Laboratory and Field Applications of Conventional and Novel Techniques for Estimating Adult and Child VSL within an Environmental Context' presented at the 17th EAERE Annual Conference in Amsterdam (June 24th-27th, 2009) (www.eaere2009.org)

  [focussing on risk communication, familiarity with the good, budget constraints]

- Alberini, Anna, Aline Chiabai and Stefania Tonin 'The VSL for Children and Adults: Evidence from Conjoint Choice Experiments in Milan, Italy' presented at the Center for

Risk Communication Research, University of Maryland, College Park (February 2009 http://freestuff.umd.edu/events.cfm?mode=detail&eventID=7733 and http://www.comm.riskcenter.umd.edu/downloads/Newsletter%20Spring%2009.pdf [p.4-Colloquium and Brown Bag Series]).

[focussing on discounting of latency, public/private risk reductions, context]

- Ščasný, Milan 'The Valuation of Environmental Health Risks for Children: Results of the VERHI Project' presented at the National Institute of Public Health, Prague.

  [focussing on determinants of VSL]

A more policy-oriented paper was presented to health professional and government officials at the 3rd WHO International Conference on Children's Environmental Health in Busan, Korea June 2009 (http://www.who.int/mediacentre/events/meetings/child_health_env/en/index.html). There were over 600 participants representing Health Ministries, Environment Ministries, international organisations, non-governmental organisations, as well as a large number of academics in the environmental health field.

In addition to these presentations, an international workshop was held in September 2009 (Charles University, Prague) at which academics, policymakers and other interested parties were invited to participate. This provided an opportunity for presentation of the main findings of the project, as well as policy implications. Leading academics served as discussants and were invited to comment on the project reports, serving as a further means of ensuring the high quality of project outputs. The workshop provided an opportunity for exchange between the research and policy communities (http://www.oecd.org/document/22/0,3343,en_21571361_36146795_37920982_1_1_1_1,00.html).

A project flyer has been produced, and can be downloaded from http://www.oecd.org/dataoecd/22/5/38410559.pdf. The initial print run of 500 has been distributed through usual OECD channels (government permanent delegations and relevant working parties), as well as to the European Commission and members of the Research Consortium. It should also be noted that the work undertaken in the VERHI project is regularly presented in the OECD newsletter "Health Update", which provides up-to-date information on OECD activities related to health (available at: http://www.oecd.org/health/update).

Four working papers are available at www.oecd.org/env/social/envhealth/verhi:

- Methodological Review of WTP and QALYs Frameworks for Valuing Environmental Health Risks to Children, James Hammitt (Harvard University) http://www.oecd.org/dataoecd/16/44/39338114.pdf

- Review and Summary of the Epidemiological Literature on Children's Health Risks Associated with Environmental Exposures, Alistair Hunt (Bath University) http://www.oecd.org/dataoecd/16/21/39338429.pdf

- Review of Revealed Preference Studies on Children's Environmental Health, Alistair Hunt (Bath University)
  http://www.oecd.org/dataoecd/16/16/39339344.pdf

- Use of Evaluation Tools in Policy-making and Health Implications for Children, Pascale Scapecchi (OECD Environment Directorate)
  http://www.oecd.org/dataoecd/6/51/39647256.pdf

The presentations from the Prague workshop are also avalailable on the project website, and other documents will be made available.

Publishable results

A number of academic articles are in preparation. It is anticipated that the participating teams will submit journal articles to a wide variety of high-quality academic journals, including the Journal of Risk and Uncertainty, Environmental and Resource Economics, Journal of Transport Economics and Policy. A tentative list of forthcoming articles includes:

- Anna Alberini, Stefania Tonin *et al.* – main results of conjoint choice experiment, focussing on Italian data

- Milan Ščasný, Hana Skopckova *et al.* – the effect of ordering on estimated value of a statistical life, focussing on Czech data

- Anna Alberini *et al.* – the value of a statistical life for children and adults in the context of road accidents

- Milan Ščasný, Stale Navrud – benefit transfer by country, context, cause of death and risk characteristics

- Ian Bateman *et al.* – the use of the chaining approach to estimate VSL for children and adults

In addition, it is foreseen that results arising out of the project will be presented at the 4th World Congress of Environmental and Resource Economists, June 28th - July 2nd, 2010 (Montreal, Canada).

A separate publication, summarising the main results of the VERHI project, will be published by the OECD in early 2010. A draft of this document is available on the OECD's password-protected website for government officials (ENV/EPOC/WPNEP(2009)/REV2). This will be a 'flagship' publication, ensuring significant visibility and dissemination. The OECD Secretariat will also prepare an OECD "Policy Brief" designed for wide dissemination of project results in a non-technical manner, targeting government officials and the general public. An article for the *OECD Observer* is also envisioned.

Planned/ actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
February 2009	Presented at the Center for Risk Communication Research, University of Maryland, College Park	Academics and students	US	30	FEEM
March 2009	Presentation at *Envecon 2009: Applied Environmental Economics Conference* (http://www.eftec.co.uk/UKNEE/envecon/2009_documents/envecon2009_ECONOMIC_VALUATION_Ferrini_presentation.pdf)	Government officials, NGOs, international organisations, academics	EU/OECD countries	300	UEA
June 2009	Presenation at 3rd WHO International Conference on Children's Health and the Environment	Government officials, NGOs, international organisations, health professionals	Approximately 200 represented	>600	OECD
June 2009	Presentation of three papers at 17th EAERE Conference (Amsterdam) web (www.eaere.org/)	Mainly academics, some government officials	OECD countries	30-40 per paper	CUEC, UEA, FEEM
June 2009	Invited keynote speech at the *XXIX Meeting of the Spanish Health Economics Association*, 17th - 19th June 2009, Malaga, Spain	Government officials, NGOs, international organisations, health professionals, academics.	EU countries	200	UEA
September 2009	International Workshop on Valuation of Environment-Related Health Impacts	Academics and government officials	OECD countries	Estimated 50	CUEC, UEA, FEEM
September 2009	Publishable final activity report	Academics and government officals		NA	OECD, CUEC, UEA, FEEM
Early 2010	Academic articles (approximately eight in total – see subjects above)	Academic	All countries	NA	CUEC, UEA, FEEM
Early 2010	OECD Policy Brief	Government officials	All countries	> 500	OECD
Early 2010	Article in *OECD Observer*	Government officials and general public	All countries	> 20,000	OECD
Mid-2010	OECD report on VERHI (with policy implications)	Government officials, NGOs, international organisations	All countries	Distributed gratis to OECD government delegations. Print run – approximately 1,000	OECD, CUEC, UEA, FEEM

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