Valuing a reduction in the risk of chronic kidney disease

A large scale multi-country stated preference approach

OECD ENVIRONMENT WORKING PAPERS NO. 216

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Organisation for Economic Co-operation and Development

ENV/WKP(2023)8

Unclassified

English - Or. English

1 June 2023

ENVIRONMENT DIRECTORATE

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Environment Working Paper No. 216

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JEL codes: D61, I18, J17, K32, Q51, Q53, Q58

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JT03520398

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Abstract

Compromised kidney function is associated with an array of environmental contaminants and chemicals, including heavy metals, certain organic solvents, and polycyclic aromatic hydrocarbons (PAHs), as well as food and waterborne pathogens. Many of these hazards are subject to regulation, or may be considered for regulation, in order to reduce exposures and prevent human health risks. However, valuation estimates for kidney effects that can be used in cost-benefit analyses are few, particularly willingness-to-pay estimates. In particular, there appears to be no willingness-to-pay (WTP) estimate available for reduced risk of chronic kidney disease and therefore no estimate for the Value of a Statistical Case (VSC) of chronic kidney disease.

This paper is part of the series of large scale WTP studies resulting from the Surveys to elicit Willingness to pay to Avoid Chemicals related negative Health Effects (SWACHE) project that intends to improve the basis for doing cost benefit analyses of chemicals management options and environmental policies in general. The present paper details a stated preference survey estimating WTP to reduce the risk of symptomatic chronic kidney disease, termed serious kidney disease in the survey instrument, filling an important gap in the valuation literature and addressing a need for applied benefits analysis for chemicals regulation. The SWACHE chronic kidney disease survey was fielded in 10 countries: Canada, Chile, China, Denmark, Germany, Italy, Norway, Türkiye, the United Kingdom and the United States. In each country, a sample of 1 200 individuals representative of the general population was collected and empirically analysed.

Based on this survey, the mean (median) WTP for an average reduction of 3.5 in 1 000 in the risk of serious kidney disease over five years is equal to USD_{2022} Purchasing Power Parity (PPP) 2 609 (764) per year, corresponding to a mean (median) VSC of chronic kidney disease equal to USD_{2022}PPP 805 000 (224 000). The mean VSC varies between USD_{2022} PPP 700 000 for Canada and USD_{2022} PPP 1 200 000 for Türkiye.

Keywords: kidney disease, health risk, economic valuation, health valuation, morbidity valuation, monetised benefits, chemicals regulation, non-market valuation, stated preferences, surveys, willingness-to-pay, value of a statistical case.

JEL Codes: D61, I18, J17, K32, Q51, Q53, Q58

Résumé

La dégradation de la fonction rénale est associée à toute une série de contaminants et de composés chimiques présents dans l'environnement, notamment les métaux lourds, certains solvants organiques et les hydrocarbures aromatiques polycycliques (HAP), ainsi qu'à des agents pathogènes d'origine alimentaire ou véhiculés par l'eau. Nombre de ces composés chimiques font l'objet d'une réglementation, ou sont susceptibles d'être réglementés, afin de réduire les expositions et de prévenir les risques pour la santé humaine. Toutefois, les estimations de valorisation des effets sur les reins pouvant être utilisées dans les analyses coûts-bénéfices sont peu nombreuses, en particulier les estimations de consentement à payer. En particulier, il ne semble pas y avoir d'estimation du consentement à payer (CAP) pour la réduction du risque de maladie rénale chronique et donc pas d'estimation de la valeur d'un cas statistique (VCS) de maladie rénale chronique.

Ce document fait partie d'une série d'études portant sur le consentement à payer et réalisées à grande échelle dans le cadre du projet SWACHE (Surveys to elicit Willingness to pay to Avoid Chemicals related negative Health Effects). Ce projet vise à améliorer la réalisation des analyses coûts-bénéfices des options de gestion des produits et composés chimiques et des politiques environnementales en général. Le présent document détaille une enquête sur les préférences déclarées estimant le consentement à payer pour réduire le risque de maladie rénale chronique symptomatique, appelée maladie rénale grave dans le questionnaire d'enquête. Ce document comble ainsi une lacune importante dans la littérature portant sur la valorisation et répond à un besoin dans la quantification des bénéfices lors de l'évaluation des options de gestions des produits et composés chimiques. L'enquête SWACHE sur la maladie rénale chronique a été menée dans 10 pays : Canada, Chili, Chine, Danemark, Allemagne, Italie, Norvège, Türkiye, Royaume-Uni et États-Unis. Dans chaque pays, un échantillon de 1 200 individus représentatifs de la population générale a été recueilli et analysé empiriquement.

Sur la base de cette enquête, le CAP moyen (médian) pour une réduction moyenne de 3,5 sur 1 000 du risque de maladie rénale grave sur cinq ans est égal à USD2022 2 609 (764) en parité de pouvoir d'achat (PPA) par an, ce qui correspond à une VCS de maladie rénale chronique moyenne (médiane) égale à USD2022 PPA 805 000 (224 000). La VCS moyenne varie entre USD2022 PPA 700 000 pour le Canada et USD2022 PPA 1 200 000 pour la Türkiye.

Mots-clés : maladie rénale, risque pour la santé humaine, valorisation économique, valorisation de la santé, valorisation de la morbidité, bénéfices monétisés, réglementation des composés chimiques, valorisation non marchande, préférences déclarées, enquêtes, consentement à payer, valeur d'un cas statistique.

Classification JEL : D61, I18, J17, K32, Q51, Q53, Q58

Acknowledgements

The paper was prepared in the context of the SWACHE project by Chris Dockins, Damien Dussaux, Charles Griffiths, Nathalie Simon and Sandra Hoffmann. This work was undertaken under the guidance of Olof Bystrom, Team Lead at the Environment and Economy Integration Division and Eeva Leinala, Principal Administrator at the Environment, Health and Safety Division at the OECD Environment Directorate. The work benefited from the overall supervision of Shardul Agrawala, Head of the Environment and Economy Integration Division at the OECD Environment Directorate.

The SWACHE project is organised in co-operation between the OECD Working Party on Integrating Environmental and Economic Policies (WPIEEP) and the Working Party on Risk Management (WPRM) and with the support or the SWACHE advisory group including experts in chemicals regulation, toxicology and economic valuation that was set up for this project.

The authors are grateful to delegates of the WPIEEP, delegates of the WPRM and members of the expert advisory group for their helpful comments and valuable feedback. The authors are also thankful to Nicolina Lamhauge of the OECD Secretariat for review of the outputs and communication support. The authors would also like to thank Nils Axel Braathen for the initial coordination of the SWACHE project. Illias Mousse Iye and Ivan Babiy provided editorial assistance and Elizabeth Del Bourgo, Lea Stapper and Clara GaÏda provided communications support.

This paper was co-funded by the European Union. The views expressed herein do not necessarily reflect the official views of the OECD or of the governments of its member countries and can in no way be taken to reflect the official opinion of the European Union.

This paper has also been produced with the financial assistance of Canada, France, the Netherlands, Norway, Poland, Sweden, Switzerland, the United Kingdom and the United States. The authors wish to thank the European Chemicals Agency for its contributions throughout the SWACHE project. The views expressed herein do not necessarily reflect the official views of the OECD or of the governments of its member countries and can in no way be taken to reflect the official opinion of OECD member countries. Finally, the views expressed here do not represent those of the US Environmental Protection Agency, the US Department of Agriculture, or the US Government.

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Chronic kidney disease affects 9.1% to 13.4% of the worldwide population (between 700 million and one billion people) and can lead to major health complications such as cardiovascular disease, increased risk of broken bones and weakened ability to fight infections. Chronic kidney disease, also called serious kidney disease, may also lead to kidney failure that requires a kidney transplant to survive or regular dialysis that strongly impact quality of life negatively. Compromised kidney function is associated with an array of environmental contaminants and chemicals, including heavy metals, certain organic solvents, and polycyclic aromatic hydrocarbons (PAHs), as well as food and waterborne pathogens.

Many of these hazards are subject to regulation, or may be considered for regulation, in order to reduce exposures and prevent human health risks. However, valuation estimates for kidney effects that can be used in cost-benefit analyses are few, particularly willingness-to-pay estimates. In particular, there appears to be no willingness-to-pay (WTP) estimate available for reduced risk of chronic kidney disease in the general population. In the absence of WTP estimates, analyses typically use cost-of-illness estimates (medical treatment costs plus the value of time lost to illness) which economic theory shows is generally an underestimate of willingness to pay to avoid illness.

To improve the basis for doing cost-benefit analysis of chemicals management options and environmental policies in general, this paper, reports on a new stated preference study valuing serious kidney disease that is part of the series of large scale WTP studies resulting from the Surveys to elicit Willingness to pay to Avoid Chemicals related Health Effects (SWACHE) project. Previous WTP studies either focused on reduced risk of kidney failure, which does not capture consider the longer and more common phase of chronic kidney disease prior to kidney failure or focused on reduced risk of chronic kidney disease relying on elicitation methods that did not produce WTP estimates consistent with the severity and length of the valued illness.

The present paper reports on a new stated preference study that address these issues by estimating the value per statistical case (VSC) of chronic (serious) kidney disease. To that end, an online valuation survey was administered to 12 000 respondents from ten OECD countries representative of the respective general populations. The survey asked respondents to provide a yes or no response on their willingness to pay a stated cost for a reduction of their risk of developing serious kidney disease over the next five years.

The WTP values provided in this study are uniquely valuable for socio-economic analysis practitioners and policy makers since they are derived for different countries using the same methodology and are therefore internationally comparable. Furthermore, because the present study is part of the SWACHE project that provides an economic valuation of 10 health effects using the same general approach, the values provided by the present report are also comparable across health effects. This large scale and comprehensive valuation effort, that to our knowledge has not been attempted previously, will facilitate quantitative analyses of chemicals management options and be helpful in formulating national and regional policy affecting health outcomes.

Across the countries surveyed the survey results indicate a mean WTP of USD_{2022} Purchasing Power Parity (PPP) 2 609 per year and a median WTP of USD_{2022} PPP 764 per year for an average reduction of 3.5 in 1 000 in the risk of serious kidney disease over five years, corresponding to a mean VSC of USD_{2022} PPP 805 000 and to a median VSC of USD_{2022} PPP 224 000. The study also derives country-specific VSC of serious kidney disease, which mean values vary between USD_{2022} PPP 700 000 for Canada and USD_{2022} PPP 1 200 000 for Türkiye.

Various checks indicate that both the mean and the country-specific estimates derived in the present study are fairly robust towards different modelling, data cleaning and screening choices.

1 The valuation of serious kidney disease

1.1. Introduction

Governments in OECD member countries regularly conduct cost-benefit analysis to help policy makers understand the merits of major policy proposals. Ideally, the assessment of policy benefits should reflect the affected population's willingness to pay (WTP) for those benefits (Sartori et al., 2014[1]; Boardman et al., 2017[2]; Johansson and Kriström, 2018[3]; OECD, 2018[4]) Socio-economic analyses of chemical regulation require both chemical risk assessments and measures of the monetary benefits to reduce these chemical risks (Chiu, 2017[5]). While there is a rich literature on willingness to pay to reduce mortality risk, it is widely recognised that there are relatively few studies of willingness to pay to reduce risk of non-fatal outcomes (Cameron, 2014[6]).

This report presents the results of a survey focused on serious kidney impairment, defined as stage 3+ chronic kidney disease. Chronic kidney disease affects 9.1% to 13.4% of the worldwide population (Hill, 2016[7]; Bikbov et al., 2020[8]; Sundström et al., 2022[9]) and can lead to major health complications such as cardiovascular disease, increased risk of broken bones and weakened ability to fight infections. Chronic kidney disease may also lead to kidney failure that requires a kidney transplant to survive or regular dialysis that strongly impact quality of life negatively. Serious kidney impairment has been linked to exposure to several chemicals, including heavy metals, certain organic solvents, polycyclic aromatic hydrocarbons (PAHs), and biotoxins (Kataria, Trasande and Trachtman, 2015[10]). Kidney effects have also been associated with exposures to "GenX" chemicals (a trade name for a technology used to make high-performance fluoropolymers) and perfluorobutane sulfonic acid (PFBS) (US EPA, 2018[11]). Food safety authorities in OECD countries regulate the presence of some biological organisms in foods, e.g., Shiga toxin-producing *E. colis,* because they create biotoxins which can cause serious kidney damage (FAO and WHO, 2022[12]).

In the absence of WTP estimates, analyses typically use cost-of-illness estimates (medical treatment costs plus the value of time lost to illness) which economic theory shows is generally an underestimate of willingness to pay to avoid illness (Harrington and Portney, 1987[13]). Therefore, the benefits of reducing morbidity impacts due to chemical exposures are potentially underestimated in socio-economic analyses.

In some cases, WTP may be estimated through market transactions with revealed preference methods for specific populations, but more often the only way to capture the full WTP to avoid illness that is representative of the general population is to conduct a stated preference study. This is an approach using carefully constructed surveys where individuals are asked to report their WTP to reduce chemical pollution or risk, or avoid the illness associated with exposure. Contingent valuation methods and discrete choice experiments are the most common types of stated preference surveys, and WTP figures based on these methods have been used in assessment efforts (Alberini, 2017[14]).

Box 1.1. The OECD SWACHE Project

Chemicals are part of our daily life and must be soundly managed to limit risks to human health and the environment. While countries around the world are setting up legal frameworks to address these risks, the cost of policy inaction is still poorly understood. Assessment of chemicals management options and environmental policies can be considerably improved by better estimating their costs and benefits. The resourcing of national chemicals management programmes also often requires economic justification of the benefits of such investment. However, current socio-economic analyses of chemical regulations use values for morbidity impacts that are often incomplete. In most cases, these values cover only lost productivity, lost earning or cost-of-illness and disregard the disutility costs of pain and suffering from the illnesses (Navrud, 2018[15]).

The OECD project Surveys on Willingness to Pay to Avoid Negative Chemicals-Related Health Impacts (SWACHE) brings together expertise on chemical safety and economic analysis to fill this gap. The project aims to establish internationally comparable values for the willingness-to-pay (WTP) to avoid negative health effects due to exposure to chemicals. Such values can be used to demonstrate and measure the economic benefits of minimising the impacts of chemicals on human health. Moreover, by using similar methodologies, survey design, approach to analyse survey data across 10 health impacts and implementing the surveys in parallel in a large number of countries, the SWACHE project offers a unique perspective that make it easier to compare the value of health impacts across health outcomes as well as across countries.

The only way to capture the full WTP to avoid illness is to conduct a stated-preference study, i.e., surveys where individuals are asked to report their WTP to reduce their risk of negative health impacts due to chemicals exposure. Contingent valuation methods and discrete choice experiments do just that, and WTP figures based on these methods have been used in assessment efforts (Alberini, 2017[14]). To derive WTP values, surveys of a large number of citizens of countries have therefore been conducted under the SWACHE project. Particularly, these stated preference surveys provide data that can shed light on the disutility in terms of symptoms and lower quality of life of a given disease or health effect, which is not captured by existing metrics such as those based on the cost of illness.

The SWACHE project is organised in two rounds, each focusing on 5 health effects each. The first round of health effects includes asthma, infertility, IQ loss, chronic kidney disease and very low birth weight. The first round of surveys was implemented in 2022 in at least five countries each where representative samples of at least 1 200 respondents each were collected. Overall, one to five of the surveys were implemented in 22 countries, totalling 46 surveys conducted. Survey responses are empirically analysed to estimate mean WTP for a given reduction in health risk for each country surveyed. The second round of surveys will include hypertension, miscarriage, skin sensitisation, thyroid dysfunction and non-fatal cancer and will be implemented in 2023-2024.

The results of this first round are presented in five working papers, one for each health effect. The research described in individual working papers makes a variety of empirical contributions to health valuation in the context of chemicals exposure, although, by design, the approach was not to break new conceptual, theoretical, or econometric ground. Moreover, the comparison of the estimated WTP across health effects and across countries will be carried out in a separate summary paper, which will also provide guidance for the transfer of WTP value over time and to non-surveyed countries.

The OECD is working to remedy the lack of estimates for major health outcomes caused by chemical exposures by implementing a coordinated set of stated preference surveys, the Surveys on Willingness to pay to Avoid negative Chemicals-related Health Effects (SWACHE) project. As described in Box 1.1, this unique collaboration from which the present study is one of the outcomes, involving partners and experts

from many countries, aims to establish internationally validated and comparable WTP values for several health outcomes associated with exposure to chemicals. WTP estimates can considerably improve assessments of chemicals management options and environmental policies in individual countries. Further, conducting substantively identical surveys in multiple countries for the same health endpoints provides opportunities to use the results to examine alternative methods for benefit transfer across countries.

1.2. Prior research

Four recent studies have estimated WTP to avoid or reduce chronic kidney disease. Two of these studies do not provide results directly relevant for use in cost-benefit analysis for chemicals due to the outcomes chosen for evaluation. Herold (2010[16]) conducted a stated preference survey of 107 US patients with chronic kidney failure (end-stage renal disease) to explore factors influencing their WTP to secure a kidney for transplant. Herold does not report mean WTP but notes that 21% of the respondents had a WTP of USD 0 and the remainder had WTPs that ranged from less than USD_{2010} 2 000 to over USD_{2010} 50 000. The most common response was USD_{2010} 5 000 to USD_{2010} 9 999 for 14% of the sample. A study by Kjaer et al. (2013[17]) used a discrete choice experiment of 206 respondents to estimate WTP to establish nephrology treatment facilities in Greenland for patients with chronic renal failure. The study estimated that the benefits of establishing treatment facilities exceeded the costs, but this cannot be readily interpreted as the WTP to reduce the risk of kidney disease.

The European Chemicals Agency (ECHA) (2014[18]) estimated WTP to avoid acute kidney injury and WTP to reduce risk of chronic kidney disease in the Czech Republic, the United Kingdom, the Netherlands and Italy. The acute kidney injury was defined as temporary, involving four weeks of symptoms, including two weeks of hospitalisation for dialysis. WTP to reduce the risk of acute kidney injury was estimated in a dichotomous choice contingent valuation survey. Mean WTP to avoid a case was EUR_{2017} 532.

More relevant for the focus of the present paper is the work of ECHA (2016[19]) on valuing chronic kidney disease. The study defined chronic kidney disease as occurring when kidneys cease to work properly, requiring dialysis three times per week and lasting for the rest of one's life. The quality of life impact was briefly described as limiting to one's ability to work and carry out common activities. Importantly, the illness as described is not the full range of symptoms and effects of symptomatic chronic kidney disease, but only its final stage, known as kidney failure or end-stage renal diseases. The reduced risk of illness was not valued directly but through a chaining approach following Carthy, et al. (1999[20]) where WTP estimates for one type of illness are combined (or chained) with standard gamble questions on another to infer WTP for the latter. So, though respondents were not presented with risk-monetary trade-offs for chronic kidney disease, WTP could nevertheless be estimated. Using this chaining approach, WTP to avoid kidney failure was estimated at EUR_{2017} 2 750. Notably, this value is quite small relative to the much less severe, and temporary, acute kidney injury outcome and the authors suggest both estimates be "treated with caution" in part because responses do not seem to show consistency in terms of illness length or severity. A subsequent evaluation of the study also noted these shortcomings and recommended the kidney disease values should not be used in applied cost-benefit analysis (ECHA, 2016[19]).

Rigby, et al. (2017[21]) prepared for the UK Food Standards Agency and Food Standards Scotland used a dichotomous choice approach to estimate WTP to avoid "Chronic Renal Failure" (again defined in the survey as permanent kidney failure or end-stage renal disease). One sample of respondents was asked about their WTP to avoid "chronic kidney failure" in themselves, and another sample (of parents) was asked about their WTP to prevent "chronic kidney failure" in their child. As with the ECHA study, the survey does not consider the longer and more common phase of chronic kidney disease prior to kidney failure. The disease description explains that kidneys cleanse the blood, and that dialysis will be needed until a transplant becomes available (in 1, 3, 6, or 10 years), but it does not describe the process of dialysis. The

study found WTP of EUR_{2017} 51 750 for a statistical case of renal failure in adults and EUR_{2017} 165 000 for children. The study also estimated a WTP of EUR_{2017} 196 000 for a statistical case of Haemolytic Uraemic Syndrome in children, a disease with serious kidney effects, often caused by biotoxin exposure from food contamination.

In sum, there appear to be no studies that provide WTP estimates for serious chronic kidney disease generally and produce results applicable to valuing the impact of serious chronic kidney disease for cost-benefit analysis.

1.3. Current effort: SWACHE project and selection of kidney disease

Given the paucity of WTP estimates for the risk of kidney disease and its association with many chemicals, it was identified as one of five priority health endpoints for valuation through SWACHE, along with infertility, asthma, very low birth weight, and IQ loss. The OECD recruited a panel of prominent experts and academics to develop a common general approach to valuing these endpoints through stated preference methods, while still allowing the surveys for each endpoint to be tailored to specific requirements. Draft survey instruments were formally distributed and reviewed by the expert panel as well as delegates from OECD member countries in September 2019 and April 2020 and surveys were revised each time based on comments received. As the surveys evolved through focus group and one-on-one interview testing, as well as reviews by health professionals and other experts, additional less-formal discussions among the expert panel were held to help ensure the survey instruments elicit the WTP of respondents using adequate and appropriate stated preferences methods. Box 2.1 describes the SWACHE survey development process in greater detail.

While SWACHE is a coordinated effort, specific decisions about how to structure the valuation question were greatly influenced by the particular needs of the individual health endpoints. For kidney disease, several alternatives were considered for the valuation scenario and payment vehicle. First, using a private product with reduced risk of chemical exposures and reduced health risks was considered, but it seemed implausible that a specific set of products would affect only kidney disease and no other organs. Furthermore, kidney disease is a complex and often unfamiliar illness that requires careful and relatively detailed description. An extensive discussion of both the health effects and of the characteristics of a product to reduce the risk of these effects would have led to a lengthier survey instrument. A scenario where risk reduction was provided by preventative medical treatment with associated out-of-pocket payments was also tested. This scenario, however, did not test well in countries with some form of public provision of health care, often leading to confusion and scepticism in respondents about why such treatments were not already covered. With input from the expert panel, a non-specific risk reduction mechanism with out-of-pocket payments was ultimately chosen, an approach that appeared to be accepted in pre-test interviews and the final survey instrument as shown below.

The results here are the first WTP values for kidney disease that are broadly applicable for cost-benefit analysis. These estimates are not specific to chemicals regulation but can be used for economic analysis of any policy that affects the risk of kidney disease. These WTP estimates are then used to calculate the value of a statistical case which translates WTP into the form that is most often used to value policy outcomes.

This paper is organised as follows. Section 2 presents the survey design. Section 3 present the empirical strategy including data sources, sample representativeness, key descriptive statistics and modelling approach. Results are provided in Section 4. Finally, Section 5 provides recommended values for serious kidney disease risk to use in policy analysis and Section 6 concludes.

2 Survey design

2.1. General SWACHE approach to survey design

All surveys developed in the SWACHE project shared a common approach. As described in Box 2.1, this includes: development of a clear definition and description of the health effect (endpoint) to be valued, a risk reduction mechanism, a payment vehicle and an elicitation method developed in consultation with the SWACHE expert panel, harmonised approaches to risk communication, harmonised background and debriefing questions, and an agreed upon approach to adapting the survey for use in different countries and to pretesting and fielding.

2.2. Disease definition and description

An essential element of any stated preference survey is a clear definition and explanation of the good being provided, in this case, a reduction in risk of kidney disease. To be useful in regulatory analysis, the survey must not only describe outcomes that are medically accurate and salient for respondents but that are also compatible with the health outcomes evaluated in human health risk assessment from epidemiologic or toxicological data (US EPA, 2014[22]).

Kidneys are critical to the healthy function of the human body. They filter waste products and extra water from the blood, maintaining a proper balance of water, salts, and mineral, help regulate blood pressure, and produce hormones that stimulate the production of red blood cells and affect bone strength (NIH and NIDDK, 2018[23]).

Kidney disease can be acute or chronic. Acute kidney disease is typically the short-term impact of an injury or illness, and a kidney can generally recover capacity after acute kidney disease. Sometimes acute kidney disease progresses into a chronic condition in which the kidneys progressively lose function. This is called chronic kidney disease. There is no cure for chronic kidney disease, but progression can be slowed through treatment and lifestyle management. Chronic kidney disease can be congenital but is more commonly a co-morbidity of other conditions such as diabetes or hypertension. It can also result from exposure to synthetic or natural chemicals, such as biotoxins produced by certain bacteria.

Health professionals characterise chronic kidney disease as having 5 stages defined in terms of clinical measures of kidney function. Stages 1 and 2 are generally asymptomatic and referred to as early chronic kidney disease. Stages 3 and 4 may begin as asymptomatic, but as the disease progresses the afflicted may experience progressively worsening symptoms and complications. Stages 3 and 4 are referred to here as “serious chronic kidney disease”. Stage 5 involves complete and permanent kidney failure. In Stage 5, or “end stage renal disease”, the kidneys do not function, and the ill person must either go onto dialysis or have a kidney transplant to survive.

Based on findings from the literature the committee identified a need for a WTP survey that values people’s willingness to pay to reduce risk of the full progression of chronic kidney disease, not only end stage renal disease. Chronic kidney disease is an important endpoint in many areas of chemical hazard regulation and this survey is designed to fill that gap.

Box 2.1. Development of SWACHE survey questionnaires and application of best practices

Each SWACHE survey questionnaire was drafted by a team of authors that includes recognised experts in the field of stated preference surveys related to health impacts as well as practitioners in the socio-economic analysis (SEA) of chemicals management options.

Each survey questionnaire was developed in several steps. First, a description of the health effect (endpoint) was drafted including information about the related quality-of-life health impact, a review of any prior stated preference studies on the same health effect and suggestions for how to characterise the endpoint in a new study. Second, various valuation scenarios were developed describing the target population, the risk reduction mechanism, the payment vehicle and the elicitation method. Third, a complete draft survey questionnaire was developed including the most appropriate valuation scenario.

A steering group of experts including internationally renowned academics, SEA practitioners, regulators and health professionals provided regular feedback throughout the process. The final working papers were reviewed by the expert group as well as by country delegations as per the OECD review process.

All SWACHE survey instruments featured a harmonised introduction that contains language to minimise non-response bias and comply with ethics principles:

> *Welcome!*
>
> *This survey is part of an international initiative coordinated by the Organisation for Economic Co-operation and Development (OECD) that aims to help design better policies.*
>
> *The survey asks for your views about a proposal to reduce the risk of [health effect] due to the exposure to chemicals and chemical products.*
>
> *Please read all the information and answer the questions carefully.* ***There are no right or wrong answers to the questions asked in this survey. It is your honest opinion that matters to us.*** *The survey can be completed on a mobile device, but we recommend doing it on a larger device, such as a tablet, laptop or desktop.*
>
> *We will ask some questions related to your health, habits and attitudes. Rest assured that a "Prefer not to answer" option will be available for you to select, at your discretion.*
>
> *Your answers throughout this survey will be kept* ***confidential****. Participation in the survey is* ***voluntary*** *and you may withdraw consent at any time by writing to support. Before agreeing, please also read this information sheet [hyperlink to information sheet screen].*

The informed consent of all participants to the surveys was collected by the internet panel provider. All survey response data are anonymised and participation in the survey was voluntary. In addition, best practices in terms of safe data storage are applied.

A description of the SWACHE project and the first five draft questionnaires were submitted to an institutional review board, the Inserm Ethics Evaluation Committee (CEEI), for an external, independent ethics review.[1] The submission process included a detailed description of the research project including type of data collected, measures to protect personal data, research objectives, research hypotheses and methodology. CEEI gave a favourable opinion on the project and had no significant concerns.

All survey questionnaires also include language to minimise non-response bias within the questionnaire. For example, the following language reduces the risk of "yea"-sayers:

> ***Please keep these things in mind***
>
> *In surveys such as this one, people sometimes say that they would pay for a reduction in risk even if they cannot afford it.*
>
> *Please treat the following questions as if they were a real-life situation, so that your answers are as accurate as possible.*
>
> *Don't agree to pay an amount that you cannot afford to pay or if you feel that there are more important ways to spend your money.*
>
> *When answering the next questions, please consider:*
>
> *your personal income and savings*
>
> *that the payment would reduce your spending on other things you may value.*

All surveys included harmonised debriefing questions to collect data on predictors of WTP such as income and age but also questions to control for non-response bias in empirical analysis. For instance, respondents were asked how much they agree with the following statements:

- I responded to the survey as I would have done in real life.
- The survey provided me with enough information to make informed choices.
- Did you agree or disagree with the description of [health effect] provided in this survey?

All survey questionnaires included a series of debriefing questions specific to the health effect valued in order to capture potential co-benefits or protests linked to the risk reduction mechanism. These survey specific questions are described in individual working papers.

Finally, all draft surveys questionnaires were tested in at least ten one-on-one interviews with people of various background and characteristics in an English-speaking country and in a non-English speaking country. The survey questionnaires were programmed and extensively tested. The translation into languages of target countries was verified by native speakers. Some surveys benefited from a pre-pilot to further revise the survey questionnaires.

Each survey questionnaire was piloted in all target countries with 50 survey responses per country. The pilots allowed for calibration of the bid levels that were presented to respondents to maximise the even distribution of responses across the four possible outcomes of the double bounded dichotomous choice.

2.2.1. Coordination with risk assessment outcomes

A key consideration for framing any valuation study relevant to regulatory analysis is coordinating the outcomes in the survey with the outcomes likely to be provided by human health risk assessment. For most chemicals, epidemiological evidence is insufficient to provide quantitative estimates of health effects at varying levels of exposure. Given this limitation, risk assessment information will likely continue to be primarily based on animal bioassays. On the other hand, direct epidemiological evidence for biotoxins is more extensive since they often initially have an acute impact on kidneys and are therefore able to be picked up in disease surveillance data. The SWACHE kidney survey instrument was developed to provide results that can be used to value outcomes provided by either stream of scientific evidence.

A major challenge for regulatory benefits analysis that relies on risk assessments is that specific animal effects do not necessarily map directly into human clinical outcomes. For example, the US Environmental Protection Agency (EPA)'s draft Chemical Risk Assessment for n-Propyl Bromide derived a benchmark

[1] See https://www.inserm.fr/en/ethics/ethics-evaluation-committee-ceei-irb/.

dose limit (BMDL) of kidney effects based on increased incidence of pelvic mineralisation in the rodent species (US EPA, 2016[24]). Other animal endpoints included increased organ weight and clinical chemistry changes. For policy purposes, these outcomes are taken to mean that some adverse health outcome is likely in humans. However, empirical analyses have generally not presumed that humans would also experience the specific animal endpoints.

For biotoxins, the immediate impact may be captured through hospital records or public health surveillance, but only in some instances do biotoxins cause immediate, complete kidney failure. Often patients will recover from acute kidney damage. In other cases, the acute kidney damage may trigger the beginning of progressive chronic kidney disease that can last for years, potentially leading to complete kidney failure. The ability to measure longer-term effects depends on the quality of continued epidemiological surveillance over many years. As a result, the impacts of biotoxin exposures are also estimated through a mix of microbial and chemical risk assessments and epidemiological evidence.

Given the uncertainty that animal endpoints are representative of human adverse health outcomes and the likelihood that most chemical risk assessments will continue to be based on animal bioassays, it was decided in the SWACHE project to value the most prominent chronic kidney effect in humans: chronic kidney disease. But, because specific levels of human health severity are not likely to be provided by risk assessments, it was decided that the endpoint should span a range of severity. Prior valuation studies generally focused on the final stage of chronic kidney disease, permanent kidney failure that requires dialysis and or kidney transplant. This is the worst-case outcome, making the value estimate relevant only for the most severe cases. In addition, this does not capture disease progression along the stages of chronic kidney disease. The SWACHE kidney survey values the health impacts of symptomatic kidney disease, including specific impacts from disease progression, and is a more useful and broadly applicable endpoint for valuation. This approach makes the results more representative of the full impacts of chemical and biotoxin exposure causing kidney disease on people's lives.

2.3. Survey structure

The survey instrument contains five sections. Following basic demographic questions (e.g., place of residence, education, income), the survey introduces the respondent to the concepts of risk and probability and the visual aids used to describe risk reductions throughout the remainder of the study. Next, the survey instrument provides background information on kidneys and their function; describes kidney disease and its causes, symptoms, and treatment; and presents the potential complications of serious kidney disease (discussed above). Respondents are then presented with a series of questions in which they are asked to state their preferences regarding hypothetical scenarios to reduce their risk of serious kidney disease. The survey closes with debriefing questions designed to better understand the responses given previously.

2.3.1. Risk communication

Because the survey elicits willingness to pay to reduce the risk of serious kidney disease, it was important to convey both baseline and changes in risk clearly. Following prior literature notably Krupnick et al. (2002[25]), the survey contains a short tutorial on risk, risk changes, and how these are presented in the survey. Risks of serious kidney disease were shown as chances per thousand over five years, displayed numerically and in a figure containing 1 000 persons (Figure 2.1). This approach is similar to risk communication devices used successfully in prior stated preference surveys for health risks (Krupnick et al., 2002[25]). Aggregation over 5 years was necessary for risk changes to be plausible and more effectively communicated to respondents given baseline risks, particularly for the youngest age group. After the risk tutorial, 91.5% of respondents correctly answered a simple test employing the risk communication device in which they were asked to identify the scenario with the highest probability of occurring.

2.3.2. Survey presentation of kidney disease

A review of the medical literature and patient education material was used to develop the description of chronic kidney disease used in the survey. The goal of the survey was to present an accurate but succinct description of chronic kidney disease, its impacts, and its causes. To do so, the US-based National Kidney Foundation staff was consulted in developing and reviewing the following description of kidney disease, treatment, and outcomes presented in the survey. Health professionals characterise kidney disease as having five stages based on how well kidneys function. To avoid overly technical language, the survey refers to stages 1 and 2 as early kidney disease, stages 3 and 4 as serious kidney disease, and stage 5 as permanent kidney failure. The following are key elements of the descriptions:

"Your kidneys filter waste products from your blood and are critical to your health. When you have kidney disease, wastes can build up in your blood and make you feel sick. Kidney disease is progressive. Even with treatment it can gradually worsen over time. Kidney disease is often described in stages based on how well the kidneys are functioning. Early kidney disease sometimes remains undiagnosed because there are typically no symptoms, and the kidneys are functioning normally or with only mild loss.

This survey will focus on **serious kidney disease**, where kidneys are not functioning well, leading to symptoms and complications. It may also lead to kidney failure, which is when your kidneys stop working. In serious kidney disease, kidneys can no longer filter blood well enough, and wastes build up in your body. This leads to symptoms that usually become more common as the disease gets worse."

The survey described that people with serious kidney disease may experience some of the following symptoms: swollen ankles, feet, or hands, lower back pain, urinating (peeing) more or less than usual, or having dark coloured urine, loss of appetite, weight loss, and nausea, difficulty concentrating, sleep problems and tiredness, shortness of breath, and decreased sex drive.

The survey described how kidney disease can lead to other major health complications:

"Serious kidney disease can lead to major health complications that can affect almost every part of your body. [These include:][2] high blood pressure and chronic heart and blood vessel (cardiovascular) disease, increased risk of heart attack, increased risk of broken bones, fluid in your lungs, erectile dysfunction in men, personality changes, or seizures, weakened ability to fight infections, pregnancy complications that carry risks for the mother and her developing foetus."

The description also included the likelihood that serious kidney disease can lead to kidney failure.

"Serious kidney disease may lead to your kidneys becoming so damaged that they stop working well enough for you to survive. This is called kidney failure. Permanent kidney failure occurs in about 35% of people with serious kidney disease, even with proper treatment. If your kidneys fail, you will need dialysis or a kidney transplant to survive."

The survey then provides a simplified, but detailed, description of what is involved in being on dialysis, the chances of finding a donor kidney, and lifestyle changes and medical care needed following a kidney transplant. In a summary of information on serious kidney disease at the end of the health outcome section of the survey respondents are reminded that:

Dialysis will help you stay alive, but it does require constant effort and time daily or multiple times a week. Kidney transplants may be possible but take an average wait of 3-5 years. It is a major surgery and requires staying on anti-rejection, or immune suppression, drugs for life. A transplanted kidney typically works for 8-20 years. A second transplant may be necessary.

[2] Square brackets indicate slight paraphrasing for presenting the information in this paper.

The description of kidney disease concludes with information on the impact of serious kidney disease on life expectancy:

Kidney disease and its treatment also affect how long people can expect to live. Average life expectancy on dialysis is 5-10 years, but this varies by age. Average life expectancy with a kidney transplant is longer. For example, a person who is 55 years old can, on average, expect to live to:

81 if they are of average health and do not have kidney failure,

60 if they have kidney failure, can't get a transplant, and need to be on dialysis,

70 if they have kidney failure and are able to get a kidney transplant

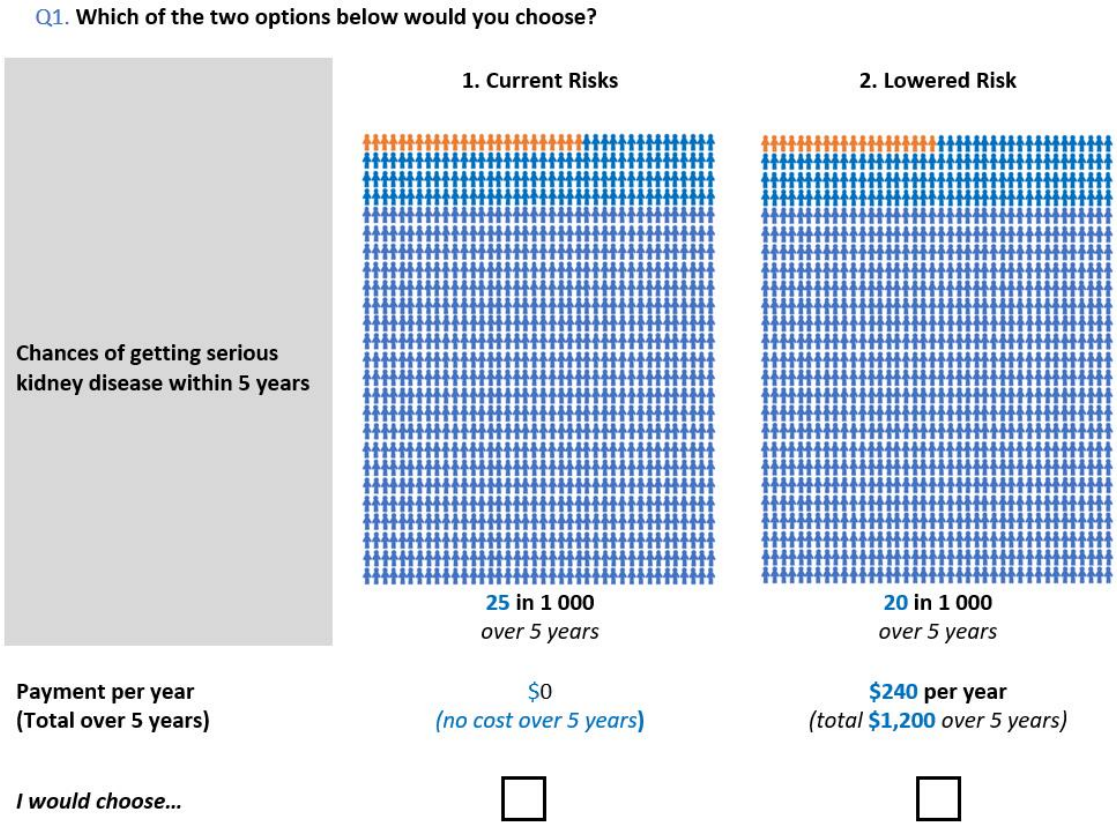
The tutorial on kidney disease concludes by briefly describing the possible causes of kidney disease.

2.3.3. Valuation questions

A key question for the choice of approach was whether it is necessary or beneficial to estimate marginal WTP for specific attributes of kidney disease. After deliberation with the SWACHE expert panel it was concluded that total WTP for reduced risk of the disease would be likely to align better with applied cost-benefit analysis. Therefore, the survey was structured as a double-bounded dichotomous choice (DBDC) question with an open-ended follow-up question. Each respondent was asked to provide a yes or no response on their willingness to pay a stated cost for a reduction of their risk of developing serious kidney disease over the next five years. Upon agreeing (declining) to pay for the risk reduction, the respondent was asked if they would pay a higher (lower) amount. Finally, the respondent was asked to state the maximum amount they would be willing to pay for the 5-year reduction in risk. Respondents were asked about one of two possible risk reductions, 2 in 1 000 or 5 in 1 000, making it possible to test for scope sensitivity. See section 3.2.1 for more information on bid levels.

In the valuation questions, risk reductions were visually presented using side-by-side grids showing the risk of serious kidney disease (in orange) with and without the intervention for a population of 1 000. Those unaffected by kidney disease were represented in blue. The baseline risks presented in the "current risk" scenario were specific to the respondent's age group, since the incidence of kidney disease increases with age. Baseline risks were based on US data and not adjusted by country in order to get values comparable across countries. One-on-one interview in non-US countries show that using baseline risk based on US data does not impact the credibility of the survey. Although the manner in which the risk would be reduced was not specific, the respondent was informed that only the risk of kidney disease would be affected, no other effects would occur, and the risk of disease would not be entirely eliminated. An example of the valuation question is shown in Figure 2.1.

Figure 2.1. Sample willingness-to-pay question



Note: Baseline risk varies depending on the respondent age category. A risk reduction of 2 or 5 in 1 000 was randomly attributed to each respondent. The first bid level was randomly attributed based on a predefined list of bid levels.
Source: Authors' own elaboration.

The risk reduction was graphically presented as occurring over five years to ease risk communication, but the payment was stated as both an annual figure and as a total over the five years. The total payment was used to estimate the value of a statistical case of serious kidney disease. This approach captures the implicit discount rate used by respondents.

2.3.4. Debriefing questions

In this survey, as in all the SWACHE surveys, a series of debriefing questions were used to access whether people's responses should be taken to represent their true preferences. These are designed to identify common issues that research has identified as of concern in all stated preference (Johnston et al., 2017[26]).

A protest response, or survey rejection, occurs when a respondent does not accept the hypothetical scenario. In this case, the answer may not indicate the respondent's actual WTP for the commodity being offered. Two debriefing questions are used to identify potential protest responses: (1) whether respondents stated that they did not answer as they would in real life, and (2) whether they thought the survey did not provide them with enough information.

Yea-saying occurs when respondents overstate their true WTP to show support for the situation described in the survey questions. To examine the potential for yea-saying, the survey asks a debriefing question about whether respondents would pay any amount to reduce risks to health. The debriefing question is not specific to kidney disease and may be interpreted broadly by respondents to include health more generally. How yea-sayers are defined for the analysis is detailed below.

Other debriefing questions were added to better understand how respondents interpreted the risk change and the scope of the benefits being provided by paying for that change. One question asked whether respondents understood that the risk reductions were to occur only over the five years described in the survey and were not permanent. Another question asked respondents whether they considered "co-benefits," that is, benefits beyond those described in the scenario.

This paper provides empirical results demonstrating the robustness of the baseline estimates to excluding responses that may be interpreted as yea-saying and protests, as well as excluding those that misunderstood the length of the risk reduction, and those that considered health benefits in addition to kidney disease. Finally, it was possible to verify whether respondents appear to be responding in ways consistent with utility theory, namely, exhibiting positive income elasticity, sensitivity to the size of the risk reduction, and sensitivity to bid amount.

2.4. Pretesting and fielding the survey

The survey was pre-tested in 51 one-on-one interviews in Chile, Denmark, Italy and in the United States. As noted above, early interviews made it clear that a scenario based on treatment costs was not viable, raising an array of questions about why it was not covered by existing public health programmes, and how the payments related to those programmes. Consequently, the survey relies on a scenario where the mechanism for reducing risk is not specified, but the costs are clearly out of pocket expenses. This approach has been used successfully in prior stated preference surveys (Krupnick et al., 2002[25]; Hoffmann, Krupnick and Qin, 2017[27]). The descriptions of kidney disease, its symptoms and complications, and the likelihood of it progressing to kidney failure were extensively tested. In particular, it was important to make clear what the probability of kidney failure was, and simple graphics seemed to convey this well. A final set of issues surrounded the time frame of the risk reduction and the payments. Because risks had to be aggregated over a 5-year period in order to make them large enough to be easily understood and for risk reductions to be plausible, it was important to communicate that this was a temporary reduction in risk over 5 years along with 5 years of annual payments. This timeframe was overlooked in early drafts of the survey instrument and language throughout was modified to make this clear.

Once the near-final version of the survey instrument was translated into the necessary languages, the translations were verified by native speakers of each country. Finally, the survey was subjected to 50-person pre-tests in each country prior to it being fielded. The purpose of the pretests was to check that the bid ranges captured the likely range of WTP responses and to identify any other significant issues that would require additional testing or revisions. As described in Section 3 bid ranges were adjusted based on the pretests but there was no need for other revisions to the survey instrument.

The survey was administered to a sample drawn from a large panel of individuals, maintained by Ipsos, who volunteer to participate in research surveys. The internet panels used for all SWACHE surveys including the kidney survey are described in detail in Box 2.2. Representative samples were drawn for each country based on quotas matching key country-specific demographic characteristics: gender, age group, level of education, and geographic region. Respondents were screened to exclude those with chronic kidney disease since this survey is designed to estimate WTP to reduce risk of developing chronic kidney disease. This is the appropriate framing of the survey since the application for cost-benefit analysis will be reducing the incidence, or number of new statistical cases, of kidney disease. A total of 14 641 individuals started the survey after passing the screening questions, and 12 614 finished the survey. This is a break-off rate of 13.8%, with 78.6% of this break-off occurring before answering the first question on risk choices. Six hundred fourteen respondents were removed by Ipsos due to a low-quality response score based on survey speeding, straight-lining, and the proportion of "don't know" answers. Straight-lining is when a respondent provides the same rating to a series of questions. Survey speeding was defined by

Ipsos as completing the questionnaire in less than one-third of the median survey time. An additional survey speeding screen on the final dataset was applied and is described below.

Box 2.2. Quality of the internet panels used in SWACHE

The field implementation of the SWACHE surveys was carried out in all surveyed countries by Ipsos European Public Affairs (hereafter Ipsos), selected after a careful call for tender process. Ipsos has significant experience in multi-country projects and maintains panels of respondents in many countries. Fieldwork, pilot and main stage, took place between June 2021 and June 2022 for the first round of surveys. The surveys were conducted via Computer-Assisted Web Interviewing (CAWI). Random samples of at least 1 200 respondents matching the target population were drawn for each country from a high-quality network of online access (non-probability) panels. Some surveys had specific requirements regarding the target population due to the endpoint under consideration. This is elaborated in survey-specific information.

Online panels are databases of potential participants who declare that they will cooperate for future data collection if selected, generally in exchange for a reward or incentive. Loyalty card and subscription databases are included here if there is a continuous relationship with members who understand the commitment asked of them. Ipsos has its own supply of sample through its globally managed i-Say (IIS) panels and some locally owned Ipsos panels. In addition, Ipsos partners with many different types of external suppliers to source sample when needed to fulfil project requirements. This includes other traditional research panels, reward or loyalty communities, intercept or offer wall providers, and sample exchanges. Ipsos can also leverage its Direct-to-Survey channel which accesses respondents directly through social media platforms. To reach respondents, Ipsos has a proprietary project management and workflow system that controls access to their panel assets and where necessary, external respondent sources.

Importantly, Ipsos implements procedures to make sure that respondents to surveys are real, unique, engaged and fresh. To ensure that their respondents are real, i.e. they are who they claim to be, Ipsos uses country geo-IP validation and digital fingerprinting to check if the respondent used a device that is truly located or if it is evading detection and also if the respondent's device has any past history of fraud. These tools used in combination with cookies can make sure that each respondent is unique and has not already accessed the survey. To guarantee respondents are engaged, their survey taking behaviour is evaluated in real time, through standard self-adjusting algorithms involving speeding and straight-lining detection (i.e., always choosing the first (or nth) answer in multiple choice). The worst offenders are automatically removed from the data deliverables and are not counted against quotas. Finally, Ipsos invited members of their panels that were fresh, i.e., that have not taken part in any of the other SWACHE surveys and were not overburdened with surveys in general.

After the main stage was completed, the online survey data were evaluated by Ipsos using several quality markers that feed into an overall quality score for each respondent: survey length and speeding, straight lining and proportion of "don't know" answers.

3 Empirical strategy

3.1. Descriptive statistics

3.1.1. *Bid amounts*

Respondents for each country were divided into age groups (18-40, 40-60, and over 60) to establish the baseline risk of serious kidney disease (15, 25, and 60 in 1 000). Members of each age group were randomly assigned into one of eight groups reflecting two hypothetical risk reductions (2 in 1,000 and 5 in 1,000) and four possible starting bids. Starting bids for the cost of risk reduction over five years for the initial pilot in the United States ranged from USD 400 to USD 4 900 but were adjusted downward due to a predominance of respondents declining the risk reduction for both dichotomous choice questions. The four starting bids for the cost of risk reduction over five years for the other nine countries in the pilot study and the main stage fieldwork were USD 300, USD 600, USD 1 200, and USD 2 400 for a 2 in 1 000 risk reduction and USD 600, USD 1 200, USD 2 400 and USD 4 800 for a 5 in 1 000 risk reduction. The follow-up bid for the second dichotomous choice question was the first bid multiplied by either two or one-half, depending on whether the respondent accepted or rejected the risk reduction following conventional approaches as described in Carson and Hanneman (2005[28]). In the dichotomous choice questions, respondents were presented with the five-year cost and the annual cost (e.g., USD 60, USD 120, USD 240, and USD 480 for the starting bids for a 2 in 1 000 risk reduction). The bid structure is shown in Table 3.1.

Table 3.1. Starting bids (total 5-year additional expenditure in USD)

Treatment group 1 (risk reduction of 2/1000)			Treatment group 2 risk reduction of 5/1000)		
Starting bid	Follow-up bid if starting bid rejected	Follow-up bid if starting bid approved	Starting bid	Follow-up bid if starting bid rejected	Follow-up bid if starting bid approved
300	150	600	600	300	1 200
600	300	1 200	1 200	600	2 400
1200	600	2 400	2 400	1200	4 800
2400	1200	4 800	4 800	2400	9 600

The bids presented to the respondents were converted from US dollars into local currency using the OECD PPP for actual individual consumption adjustment for 2019. These values were then rounded to a whole number divisible by 10 to produce a value that was easy to understand by the local respondent. For example, the lowest annual cost a respondent in the United States could have seen was USD 30. Converting this to euros for a German respondent using the PPP adjustment produced EUR 22.34. This was rounded down to EUR 20 to make it a more easily understood value. The rounded values were converted back to USD using the PPP adjustment for the WTP estimation (e.g., EUR 20 was converted back to USD 26.85). Because of this rounding, each country's bid values for the econometric analysis do not fall into discrete bins. Instead, bid values are a continuous variable. For example, the starting bid in

USD for the cost of a risk reduction over five years is USD 300, USD 600, USD 1 200, and USD 2 400 and USD 4 800 only for the United States. For the other countries, it is a range of values from USD 239.47 to USD 4 900 due to conversion and rounding.

3.1.2. ***Screening strategy***

The data were screened based on core principles for empirical analysis agreed upon by the SWACHE researchers (see Box 3.1). Ipsos controlled for low-quality response scores based on survey speeding, straight-lining, and the proportion of "don't know" answers to produce a full sample of 12 000 valid and comprehensive observations. The dataset was screened further by removing individuals who failed the survey's probability test (8.47%) and those who completed the survey or valuation questions in less than 48% of the median time of the full sample (12.4%) in order to control for potentially problematic responses in the sample provided by Ipsos. The decision to remove individuals who took less than 48% of the median time is based on the recommendations of Survey Sampling International (2013[29]) and Mitchell (2014[30]). This screening is in addition to the screening done by Ipsos based on their own practices. This screening reduced the sample from 12 000 to 9 709 observations. Additional factors that might affect the willingness to pay estimates were also identified, including: gender, monthly household income, level of education, health expenditure paid for out of pocket, higher or lower average perceived health, having a friend or relative who experienced kidney failure, being diagnosed with some other chronic disease, and being diagnosed with or having a friend or relative diagnosed with COVID-19. These additional factors were used as explanatory variables in the econometric analysis.

Box 3.1. Consistent analysis of survey responses across SWACHE health effects

Each focused on a single health effect, the SWACHE working papers will ***ultimately*** feed into an OECD summary paper that will gather the recommended estimates for WTP values and Value of a Statistical Case (VSC) for all endpoints, compare them across countries and offer comprehensive guidance for practical use by practitioners including guidance on benefit transfer that is the transfer of value over time and toward non-surveyed countries. Consequently, the different teams involved in the SWACHE project adopted a similar core strategy on how datasets would be cleaned and analysed empirically to allow the proper comparison of WTP values across countries and endpoints. A series of consensus meetings with the teams of survey authors led to the adoption of a set of Core Principles of Survey Analysis that are applied but adapted, when necessary, to survey specificities and data. As indicated in Box 1.1, the idea is not to break new conceptual, theoretical or econometric ground but set up core principles that are consistent with the economic valuation literature and are widely recognised in the field. These shared principles ensure that all the working papers apply the same empirical strategy in terms of data cleaning, screening of respondents, specification, estimators, robustness checks and guidance on which central WTP or VSC value should be used in regulatory impact analysis. The final version of these Core Principles of Survey Analysis is presented in Annex A.

The assessment of "speeders" (those who completed the survey abnormally quickly) is based on country-specific medians rather than the full sample median to take into account cross-country difference such as language. Table 3.2 lists the total sample and the country-specific median times to complete the entire survey and the combined time to answer both valuation questions. The overall median survey completion time was 14.52 minutes, and the total time to answer both valuation questions was 41.6 seconds. However, both estimates display considerable heterogeneity across counties. Some countries (e.g., the United Kingdom and the United States) are substantially below the median, and others (e.g., Italy) are well above the median. Using the overall sample median to assess survey speeders (columns (2) and (3)) would identify 7.42% of the UK sample and 6.42% of the US sample but would not identify any of respondents from Chile. Similar results occur if the full sample were used to assess valuation speeders (columns (7) and (8)). Columns (4) and (5) and columns (9) and (10) illustrate the impact of using 48% of the country-

specific medians. These columns show a much more heterogeneous identification of speeders across countries and is used for the screening for this survey.

Table 3.2. Full sample vs. country-specific speeder analysis

		Survey Speeders					Valuation Speeders				
		Median	Full Sample		Country-Specific		Median	Full Sample		Country-Specific	
Country	Obs.	(minutes)	Number	Percent	Country	Percent	(seconds)	Number	Percent	Country	Percent
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Canada	1 200	15.17	25	2.08%	40	3.33%	27	114	9.50%	83	6.92%
Chile	1 200	19.51	0	0.00%	25	2.08%	45	15	1.25%	91	7.58%
China	1 200	14.08	131	10.92%	111	9.25%	21	412	34.33%	290	24.17%
Germany	1 200	14.48	39	3.25%	39	3.25%	29	67	5.58%	67	5.58%
Denmark	1 200	14.38	49	4.08%	45	3.75%	25	171	14.25%	116	9.67%
Italy	1 200	13.07	70	5.83%	34	2.83%	27	111	9.25%	81	6.75%
Norway	1 200	14.84	36	3.00%	43	3.58%	29	94	7.83%	94	7.83%
Türkiye	1 200	15.07	26	2.17%	34	2.83%	32	133	11.08%	178	14.83%
UK	1 200	12.23	89	7.42%	35	2.92%	23	156	13.00%	91	7.58%
US	1 200	13.04	77	6.42%	41	3.42%	23	190	15.83%	110	9.17%
Total sample	12 000	14.52	542	4.52%	447	3.73%	28	1 463	12.19%	1,201	10.01%

The exception in the speeder identification analysis is China. While the Chinese country-level median time to complete the survey is close to the total sample median, China had an exceptionally large number of observations below 48% of the median. Using the full sample median would indicate 10.92% of the Chinese respondents are survey speeders and 34.33% are valuation speeders. Using the country-specific medians for China suggests that almost 10% of Chinese respondents are survey speeders, and nearly 25% are valuation speeders. Using country-specific medians and applying both criteria to identify speeders removes 28% of the Chinese sample.

3.1.3. *Imputed income*

Respondents were asked to indicate their household's monthly income after income taxes have been paid and were presented with 10 income ranges corresponding to income deciles in their respective countries. Income deciles correspond to unequivalised income that is the total (net) household income. Unequivalised income deciles are derived by multiplying equivalised income deciles in 2019 from OECD Income (IDD) database by the number of 'equivalent adults' using data on family composition from OECD Family database.[3] Respondents who did not indicated their range for the income deciles were presented bigger ranges corresponding to income quintiles in their respective countries. The vast majority of respondents (91%) provided information about the total income of their household. Income ranges were then converted into a single amount to facilitate the use of income data in the empirical analysis. For the smallest income range between 0 and first decile, the income equals 0.5 times the first decile. For the largest income range above the last deciles, the income is computed as equal to 1.5 times the top decile. For all the other incomes ranges, the computed income is the simple average between the two deciles. All income values were then converted in USD PPP using PPP for actual individual consumption data for 2019 from the PPPs and exchange rates OECD database.[4]

To derive missing income values from respondents who chose to not state it, country-level Ordinary Least Square (OLS) regression analyses of logged income as a function of age dummies, couple dummy, female

[3] See https://www.oecd.org/els/soc/OECD-Note-EquivalenceScales.pdf and https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Equivalised_income for more information on equivalized income. 2019 was chosen because it was the last year of available data before the covid-19 crisis.

[4] The PPP data was extracted on 22 Feb 2021 08:44 UTC (GMT) from OECD.Stat, but has subsequently been revised. The exact series can be provided upon request.

dummy, high education dummies, number of people in the household, employment dummy, part time work dummy, and retired dummy were performed. The models were used to predict income for respondents who did not provide it.

3.1.4. *Representativeness of the sample*

Table 3.3 below presents the sampling quota and the achieved sample for target characteristics of the screened sample, after removing country-level survey and valuation speeders and those who failed the probability test. The table shows an over-representation of females in all countries except Denmark, Norway, and Türkiye. This over-representation was present in the full sample received by Ipsos but was exacerbated by the screening strategy. The achieved sample is close to the sample quota for age groups. China and Türkiye show an under-representation and Demark an over-representation of individuals over 60. Low and medium levels of education were collapsed into a single group because of an under-representation of lower educated respondents in all countries. Higher educated respondents are close to the quota except for Norway and Türkiye.

A respondent's monthly income is the average of the income range selected, converted to USD PPP. The median monthly income for Canada, Denmark, Italy, Norway, and the United States closely match the population median. The achieved sample for Chile, Germany, and the United Kingdom show a slightly higher deviation, with an under-representation of low-income individuals. The two outliers are Türkiye and China, showing much higher income in the achieved samples than the population medians. The sample median income is 162% higher than the quota for Türkiye and is 227% higher for China.

Table 3.3. Sample quota vs. achieved sample for chronic kidney disease survey

		Canada	Chile	China	Denmark	Germany	Italy	Norway	Türkiye	UK	US
Gender											
Sample quota	Male	50%	49%	51%	50%	49%	49%	50%	49%	49%	49%
	Female	50%	51%	49%	50%	51%	51%	50%	51%	51%	51%
Achieved sample	Male	41%	44%	49%	53%	47%	45%	50%	51%	46%	39%
	Female	59%	56%	51%	47%	53%	55%	50%	49%	54%	61%
Age Group											
Sample quota	18-29	22%	26%	19%	22%	19%	17%	22%	24%	22%	23%
	30-44	28%	31%	31%	25%	25%	27%	28%	34%	27%	27%
	45-60	28%	26%	32%	29%	32%	32%	28%	27%	29%	27%
	60+	23%	17%	19%	24%	23%	24%	22%	16%	22%	22%
Achieved sample	18-29	17%	27%	23%	17%	16%	18%	18%	24%	16%	18%
	30-44	25%	35%	37%	18%	26%	27%	28%	41%	27%	28%
	45-60	31%	24%	30%	32%	32%	34%	29%	30%	30%	29%
	60+	27%	15%	10%	34%	26%	21%	26%	4%	26%	26%
Level of Education											
Sample quota	Low+Medium	41%	75%	86%	60%	70%	80%	56%	78%	53%	52%
	High	59%	25%	14%	40%	30%	20%	44%	22%	47%	48%
Achieved sample	Low+Medium	49%	71%	81%	56%	69%	79%	48%	62%	50%	57%
	High	51%	29%	19%	44%	31%	21%	52%	38%	50%	43%
Median Monthly Income (2019)											
Sample quota	USD PPP	3 727	1 188	841	3 184	2 921	2 735	3 935	1 320	2 524	4 107
Achieved sample	USD PPP	3 706	1 744	2 754	3 562	3 692	2 671	4 563	3 457	3 338	3 751

3.1.5. *Sample for baseline analysis*

Given that the Chinese sample has a median income of more than 225% of the population median and that 28% of the Chinese respondents completed the survey and valuation question exceptionally quickly,

China was removed from the baseline analysis. This reduced the sample size to 8 905 observations. China is still included as a sensitivity analysis in the main results table and in the country-level parametric estimations of WTP.

The response matrix for the dichotomous choice questions using the screened sample without China is presented in Table 3.4. "Yes" indicates that the respondent was willing to pay the bid amount to obtain the lower (safer) risk level, "No" indicates that they chose the current risk. 25% of respondents answered "Yes" to both dichotomous choice question, indicating that they were willing to pay more than the second, higher bid amount for the risk reduction. 40% of respondents answered "No" to both questions, indicating that even the second, lower bid amount was more than they were willing to pay. Approximately 15% answered "Yes" to the first question but "No" to the second one, suggesting that their willingness to pay was higher than the first bid but lower than the second. About 20% answered "No" to the first question and "Yes" to the second, implying that their willingness to pay is lower than the first bid but higher than the second.

Table 3.4. Dichotomous choice response matrix, screened sample

		First dichotomous choice question: Percent of respondents who chose to pay for the lower risk	
		No	Yes
Second dichotomous choice question: percent of respondents who chose to pay for the lower risk	No	39.89	15.41
	Yes	19.63	25.08

To test for sensitivity to scope and scale, the response to the first dichotomous choice question is broken down by the risk reduction offered and the starting bid. For presentation purposes, the starting bid is presented as the five-year cost in USD, as described in Table 3.1. In practice, the starting bid is a continuous variable because the USD values were rounded after being converted to the local currency. For both risk reduction values, the percent of respondents who answered "Yes" to the first question declines with the starting bid, indicating that respondents are less likely to be willing to pay for a risk reduction as the bid increases. This is the expected sensitivity to scale. Additionally, for the three starting bids that are common to both risk reduction values, the percent of respondents who answered "Yes" is higher for the larger risk reduction. This suggests that respondents are willing to pay for more a larger risk reduction, which is the expected sensitivity to scope.

Table 3.5. Response to first dichotomous choice question by starting bid

	Question 1: Percent of respondents who chose to pay for the lower risk	
	No	Yes
Risk reduction = 2 / 1 000		
Starting bid = USD 300	6.39	6.20
Starting bid = USD 600	7.30	5.03
Starting bid = USD 1200	8.22	4.46
Starting bid = USD 2400	8.47	3.83
Risk reduction = 5 / 1 000		
Starting bid = USD 600	5.93	6.52
Starting bid = USD 1200	6.66	5.70
Starting bid = USD 2400	7.89	4.90
Starting bid = USD 4800	8.66	3.84

3.1.6. *Summary statistics*

Table 3.6 and Table 3.7 display the summary statistics for the baseline sample of 8 905 respondents who remained after screening those who failed the probability test or were identified as a speeder, and after

removing China. Table 3.6 provides the summary statistics for the important continuous variables used in the analysis. The first block of data (5 rows) shows the time to complete the survey and the time respondents spent on the two dichotomous choice questions. Respondents answered the second risk question twice as fast as the first one, probably due to increased understanding after answering the first question. The second block of data shows the bid values for the first and second dichotomous choice questions, with the second bid being either one-half or twice the first bid value. 25% of respondents chose the lower risk (responded "yes" to paying the cost) for both risk questions, and 40% of respondents chose the current risk (responded "no" to paying the bid price) for both questions.

The last rows in Table 3.6 provides statistics for baseline risk and income, continuous variables considered to be important factors affecting willingness to pay. The baseline risk is 15, 25, or 60, depending on the age group. The PPP-adjusted reported median income ranges from USD 263 (in Chile) to USD 17 552 (in the U.S.). Almost 10% of the baseline sample declined to report their income, but the income with the imputed values used for the missing responses produces a very similar income distribution and provides 8 905 observations for the estimation.

Table 3.7 provides the summary statistics for the indicator (0/1) variables used in the analysis. The table reports the number of observations for which the variable is equal to one, and the percentage of the total 8 905 observations. The first block on the left-hand side reports the observations for each country after screening for speeders and those who failed the probability test. China is not included in this list because it was removed from the baseline sample. Denmark, Türkiye, and the US have a slightly lower percent of the observations because of a larger number of speeders and respondents who failed the probability test. The second two blocks on the left-hand side of Table 3.7 shows the age gender distribution of the baseline sample. As noted previously, there is an over-representation of females in this sample.

The first block on the right-hand side of Table 3.7 shows the distribution of responses to both risk questions. 25% of respondents chose the lower risk (responded "yes" to paying the cost) for both risk questions, and 40% of respondents chose the current risk (responded "no" to paying the bid price) for both questions. Approximately 15% and 20% of the respondents answered “yes-no” and “no-yes” to the first and second dichotomous choice question, respectively

The second block on the right-hand side provides statistics for the indicator variables considered important factors affecting willingness to pay. A large percentage of respondents (38.7%) believe that their health is better than average, while 15.9% self-report lower than average health. The majority of respondents (65.8%) have never been diagnosed with a chronic disease, but over a third (34.8%) had a relative of friend with kidney disease. Only 8.5% of respondents report having been diagnosed with COVID-19, but almost 40% have a close friend or relative who had been diagnosed with COVID.

The final block on the right-hand side of Table 3.7 contains the statistics for controls used to test the robustness of the screening analysis. 5.8% of the respondents reported that they thought the risk reduction was permanent. Eight hundred twenty respondents (9.2%) considered changes in other health issues not described in the survey (co-benefits) when they made their choices. Eleven percent of the respondents strongly agreed (on a 5-point Likert scale) with the statement that they would pay almost any amount to reduce risks to their health. Combing those who strongly agreed to pay almost anything with the 25% of respondents who answered Yes-Yes to the two dichotomous choice questions produces 6.2% of respondents classified as yea-sayers. 3.4% of respondents reported that they did not answer as they would have in real life or said that the survey did not provide them enough information to make informed choices. These respondents were classified as protesters.

Table 3.6. Summary statistics for continuous variables

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	8 905	19.7	15.2	18.2	5.9	361.2
Time for 1st dichotomous choice question (seconds)	8 905	30.5	20	71.9	3	2 414

Time for 2nd dichotomous choice question if first response was No (Current risk)	3 609	14.5	8	135.2	2	5 993
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	5 309	13.3	8	153.6	2	11 032
Total time to complete both valuation questions (seconds)	8 905	44.3	30	163.4	12	11 041
Cost over 5 years for 1st dichotomous choice question (in USD)	8 905	1 680	1 208	1 390	267	4 900
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	8 905	1 740	1 153	2 014	133	9 800
Baseline Risk (/ 1 000)	8 905	29.4	25	17.3	15	60
Monthly household income (in USD)	8 030	4 068	3 290	3 122	263	17 552
Monthly household income (w/ predicted, in USD)	8 905	4 004	3 223	3 010	263	17 552

Table 3.7. Summary statistics for indicator variables

Variable	Obs, Variable = 1	Percent of total obs.
Canada	1 047	11.8%
Chile	981	11.0%
Denmark	939	10.5%
Germany	1 031	11.6%
Italy	1 022	11.5%
Norway	1 030	11.6%
Türkiye	872	9.8%
UK	1 024	11.5%
US	959	10.8%
Age 18-26	1 166	13.1%
Age 27-34	1 267	14.2%
Age 35-39	861	9.7%
Age 40-44	888	10.0%
Age 45-59	2 675	30.0%
Age 60-65	841	9.4%
Age 65+	1 207	13.6%
Female	4 810	54.0%

Variable	Obs, Variable = 1	Percent of total obs.
Respondents who said Yes-Yes to pay for risk reductions	2 233	25.1%
Respondents who said No-No to pay for risk reductions	3 552	39.9%
Respondents who said Yes-No to pay for risk reductions	1 372	15.4%
Respondents who said No-Yes to pay for risk reductions	1 748	19.6%
Respondents with a high level of education	3 565	40.0%
Health expenditures are out of respondent's own pocket	1 226	13.8%
Health perceived as below average or did not answer	1 416	15.9%
Health perceived as above average	3 449	38.7%
Relative or friend had kidney failure	3 095	34.8%
Respondents who have never been diagnosed with a chronic disease	5 857	65.8%
Respondents who have been diagnosed with COVID-19	757	8.5%
A close friend or family member was diagnosed with COVID-19	3 534	39.7%
Respondents who thought the risk reduction was permanent	514	5.8%
Respondents who considered other health issues (co-benefits)	820	9.2%
Respondents who strongly agreed they would pay almost anything	982	11.0%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	554	6.2%
Protesters: Did not answer as in real life, or did not have enough information	301	3.4%

3.2. Estimation model

3.2.1. Estimating WTP using contingent valuation

To derive mean and median WTP estimates for a reduction in the risk of serious kidney disease (denoted ΔR), a Random Utility Model is employed, in which one can write the indirect utility of individual i as follows:

$$v(B, y_i) + \epsilon_i$$

where B denotes the baseline risk of serious kidney disease, y the income and $V(B, y)$ the indirect utility, and assuming ϵ_i is the error term. The WTP corresponds to the maximum monetary amount a person is prepared to spend to have at least the same utility level as would be obtained with the baseline risk and unchanged disposable income. That is,

$$v(B - \Delta R, y - WTP) = v(B, y)$$

where ΔR denotes a change in risk.

To estimate the WTP, it is possible to ask a sample of the population if they would pay a certain amount of money to reduce their risk of serious kidney disease. This contingent valuation method is called a single-

bounded dichotomous choice. An individual who responds yes when asked if he is willing to pay the amount b for ΔR implies that

$$v(B - \Delta R, y_i - b) + \epsilon_{i1} \geq v(B, y_i) + \epsilon_{i0}$$
$$\text{and } b \leq WTP_i.$$

Therefore, the probability that individual i chooses yes when presented b can be written as follows:

$$Pr\{Yes_i|b\} = Pr\{b \leq WTP_i\}$$
$$= Pr\{\epsilon_{i0} - \epsilon_{i1} \leq v(B, y_i) - v(B - \Delta R, y_i - b)\}$$
$$= Pr\{\epsilon_{i0} - \epsilon_{i1} \leq g(b, y_i, \Delta R, \theta)\}$$
$$= 1 - F(b, y_i, \Delta R, \theta)\ ,$$

where F is the cumulative distribution function of the error term $\epsilon_{i1} - \epsilon_{i0}$ and θ the parameter of the distribution. Assuming that the n observations are independent and identically distributed, θ can be estimated by finding the maximum of the likelihood function, which is the joint probability that all respondents choose the reduced risk option:

$$L(b, y, \Delta R, \theta) = Pr\{Yes_1, \dots, Yes_i, \dots, Yes_n|b\} = \prod_{i=1}^{n} Pr\{Yes_i|b\}.$$

The mean WTP can then be estimated by integrating the probability of choosing the reduced risk option over the interval from 0 to an infinite cost:

$$E(WTP) = \int_0^\infty Pr\{\text{Yes}|b\}db.$$

The median WTP is the bid level for which the $Pr\{\text{Yes}|b\}$ equals 50%.

3.2.2. Double-bounded dichotomous choice (DBDC) estimation

In this questionnaire, people were asked if they were willing to pay for a reduced risk of serious kidney disease using a DBDC. This elicitation method allows several of the estimated individual WTP to be bounded between two values, which is not possible using a single bounded dichotomous choice. Denote b_i as the first bid level proposed to respondent i. Denote $b_i^U = 2b_i$ as the follow-up bid level proposed to respondent i if he responded yes to the first valuation question. Denote $b_i^L = \frac{b_i}{2}$ as the follow-up bid level proposed to respondent i if he responded no to the first valuation question.

This elicitation provides four outcomes per respondent: d_i^{YY}, d_i^{YN}, d_i^{NY} and d_i^{NN}. Denote d_i^{YY} a dummy variable equal to one when respondent i chooses yes to both valuation questions. When d_i^{YY} equals 1, $WTP_i \geq b_i^U > b_i$, where b_i is the first bid level proposed to respondent i and b_i^U is the higher follow-up bid level proposed to respondent i. Denote d_i^{YN} a dummy variable equal to one when respondent i chooses yes to the first valuation question and no to the follow-up valuation question. When d_i^{YN} equals 1, $b_i \leq WTP_i < b_i^U$. Denote d_i^{NY} a dummy variable equal to one when respondent i chooses yes to the first valuation question and no to the follow-up valuation question. When d_i^{NY} equals 1, $b_i^L \leq WTP_i < b_i$. Finally, denote d_i^{NN} a dummy variable equal to one when respondent i chooses no for both valuation questions. When d_i^{NN} equals 1, $WTP_i < b_i^L$.

Based on the previous section, the probability of these four outcomes can be written as follows:

$$Pr\{YesYes|b^u\} = Pr\{b^u \leq WTP\} = 1 - F(b^u, \theta)$$
$$Pr\{YesNo|b, b^u\} = Pr\{b \leq WTP < b^u\} = F(b^u, \theta) - F(b, \theta)$$
$$Pr\{NoYes|b^L, b\} = Pr\{b^L \leq WTP < b\} = F(b, \theta) - F(b^L, \theta)$$
$$Pr\{NoNo|b^L\} = Pr\{WTP < b^L\} = F(b^L, \theta).$$

In this setting, the log-likelihood function for a sample of n respondents can be written as follows:

$\ln L(b,\theta) = \sum_{i=1}^{n}[d^{YY} Pr\{YesYes|b^u\} + d^{YN} Pr\{YesNo|b, b^u\} + d^{NY} Pr\{NoYes|b^L, b\} + d^{NN} Pr\{NoNo|b^u\}]$.

Maximizing $\ln L(b,\theta)$ permits us to estimate θ and produces the mean WTP and median WTP more efficiently than with a single bounded dichotomous choice.

3.2.3. Spike configuration with Weibull distribution of the error

So far, the analysis has assumed that people will always choose the reduced risk option when it costs them nothing or almost nothing. In other words, it has been assumed that $Pr\{Yes|b=0\} = 1$. In reality, a small share of the population might still choose the status quo even if it costs them nothing because they do not care enough about reducing their risk of developing serious kidney disease. This creates a spike near zero. This spike could be significant in the case of serious kidney disease because the baseline risk is relatively small for younger respondents. Carson and Hanemann (2005[28]) argue that failing to include a spike parameter can, in some cases, lead to overestimating WTP.

This spike near zero can be measured using the responses to the open-ended question that followed the double-bounded dichotomous choice: "What would be the most you would be willing to pay, if anything, to reduce your chance of getting serious kidney disease within 5 years?". Denote d_i^{NNY} a dummy variable equal to one when respondent i chooses no to both valuation questions but responds with a positive value to the open-ended questions. Denote d_i^{NNN} a dummy variable equal to one when respondent i chooses no to both valuation questions and responds with a value of zero to the open-ended questions. The probability of these two events is:

$$Pr\{NoNoYes|b^L\} = Pr\{0 < WTP < b^L\} = F(b^L,\theta) - F(0,\theta)$$

$$Pr\{NoNoNo|0\} = Pr\{WTP \leq 0\} = F(0,\theta).$$

These two events can be added to the likelihood function to improve information as follows:

$$\ln L(b,\theta) = \sum_{i=1}^{n}[d^{YY} Pr\{YesYes|b^u\} + d^{YN} Pr\{YesNo|b, b^u\} + d^{NY} Pr\{NoYes|b^L, b\} + d^{NN} Pr\{NoNo|b^u\} + d^{NNY} Pr\{NoNoYes|b^L\} + d^{NNN} Pr\{NoNoNo|0\}].$$

To derive the mean and median WTP, it is necessary to estimate θ and, therefore, to be able to compute log-likelihood for various values of θ. Hence, it is necessary to assume a distribution F for the utility error. In this report, the paper assumes a Weibull distribution as the baseline because it generally has a shorter right tail than the log-normal and, in its "spike" configuration, usually performs well (Kriström, 1997[31]; Carson and Hanneman, 2005[28]).

3.2.4. Control variables and use of post-stratification weight

A Weibull distribution $\theta = \{k, \lambda\}$ is characterised by a shape parameter k and a scale parameter λ. All estimations assume a shape parameter equal to 1. The baseline specification of the scale parameter when $b > 0$ is

$$\lambda_{ic}(b) = \alpha_0 + \alpha_1 \Delta R_i + \alpha_2 \ln b_i + \sum_c \delta_c (d_{ic} \times \omega_i) \qquad (1)$$

where ω_i denotes demographic weight.

The spike parameter when $b = 0$ is

$$\eta_{ic} = \alpha_0 + \alpha_1 \Delta R_i + \sum_c \delta_c (d_{ic} \times \omega_i). \qquad (2)$$

ΔR_i is the risk reduction proposed to respondent i, $\ln b_i$ is the logged cost or bid proposed to respondent i, d_{ic} is a country dummy equal to 1 when respondent i lives in country c, and ω_i is the post-stratification weight of respondent i. Including post-stratification weights, ω_i, as a control allows us to capture the fact that some categories of people were slightly under- or over-represented in the sample compared to the

actual population. The more respondent i is underrepresented in the sample, the higher their weight ω_i. It is necessary to interact country dummies with the weights because the weights are defined at the country level.

The model is also estimated when the scale parameter includes additional explanatory variables as follows:

$$\lambda_{ic}(b) = \alpha_0 + \alpha_1 \Delta R_i + \alpha_2 \ln b_i + \sum_c \delta_c (d_{ic} \times \omega_i) + \alpha_3 Female_i + \alpha_4 \ln y_i + \alpha_5 HighEduc_i + \alpha_6 Baseline_i \quad (3)$$

$Female_i$ is a dummy variable equal to 1 when respondent i identifies as a female, $\ln y_i$ is the logged monthly income for the household of respondent i, $HighEduc_i$ is a dummy variable equal to 1 when respondent i achieved high education outcome, and $Baseline_i$ is the baseline risk presented to respondent i.

The model is also estimated when the scale parameter includes information on other important factors. These factors include whether respondents must pay for health expenditure out-of-pocket; whether they perceive their health as below or above the average of people of their gender and age; whether they know a relative who had kidney failure; whether they are diagnosed with any other chronic disease; and whether they or a relative was ever diagnosed with COVID-19.

3.2.5. Deriving mean and median WTP based on individual WTP

The mean WTP for an average 3.5 in 1 000 risk reduction in serious kidney disease is computed as a simple average of the individual mean WTP follows:

$$\widehat{WTP} = \frac{1}{n} \sum_{i=1}^{n} \widehat{WTP_i}$$

The individual mean WTP is computed by integrating the probability of responding yes to the valuation question over the interval from 0 to maximum bid with adjustment:

$$\widehat{WTP_i} = \int_0^{b_{max}} \frac{f(\lambda_{ic}(b), k)}{1 - f(\lambda_{ic}(b_{max}), k)} db$$

f is the density function of the Weibull distribution and *k* denotes the shape parameter. Truncation at maximum bid level b_{max} is necessary since the right tail is not null when the cost goes to infinity. The adjustment of the denominator compensates for the fact that the support of $f(\lambda_{ic}(b), k)$ does not stop at b_{max}. The median WTP is computed as a simple average of individual median WTP as follows:

$$\widehat{WTP_i} = \frac{\ln 2}{|\alpha_2|} e^{\eta_{ic}\left(\frac{1}{|\alpha_2|}\right)}$$

α_2 is the parameter for the logged bid value as indicated in equation (1).

Mean and median WTP is also presented as the value of a statistical case of kidney disease avoided. VSC is calculated in the standard manner of dividing annual WTP by the average annual risk reduction. Because this survey asks about risk changes over a 5-year period and payments over this same period, VSC can equivalently be calculated as 5 x annual WTP divided by the average 5-year risk reduction of 3.5 per 1 000. Importantly, as with the analogous value of statistical life (VSL), the VSC cannot be interpreted as willingness to pay to avoid a case of illness with certainty. Instead, it is a normalisation of WTP to reduce risks of disease which is more often used in applied cost-benefit analysis than the WTP estimates directly.[5]

[5] This is a similar interpretation as the value of a statistical life which does not measure the value of a single life but of a statistical prevented fatality derived from the valuation of a small reduction in the risk of dying.

4 Results

4.1. Main results

The parametric estimation results of the dichotomous choice model are presented in Table 4.1. Column (1) shows the baseline estimation results. The size of the risk reduction has a positive and statistically significant effect on the joint probabilities of choosing the reduced risk options, indicating scope sensitivity. Consistent with expectations, the additional cost of choosing the reduced risk option has a negative and statistically significant effect on the likelihood that it is chosen. The spike variable equals 0.035 and is statistically different from zero. In other words, the average probability that people are indifferent to the valued item is 3.5% the estimation sample. This spike at zero is small but high enough to justify using a spike model. For an average reduction of 3.5 in 1 000 in the risk of serious kidney disease over five years, the mean WTP equals USD 2 609 and the median WTP equals USD 764. The mean value of a statistical case (VSC) of serious kidney disease equals USD 805 000 and the median VSC equals USD 224 000.

These results are robust to alternative methodological choices. Column (2) shows the estimation results when the post-stratification weights and its interactions with country dummies are not included as regressors. Column (3) excludes the possibility of a spike at zero. Column (4) assumes a log-logistic distribution rather than a Weibull distribution, while column (5) assumes a log-normal distribution. Column (6) includes survey responses from China, and column (7) excludes survey responses from Türkiye. China was excluded from the baseline model for reasons described above. Türkiye was excluded in column (7) because the median income of respondents from Türkiye is twice as high as the median income of the population of Türkiye. All columns show statistically significant scope sensitivity and a negative impact of cost on the joint probabilities to choose the reduced risk option that is statistically different from zero. The mean VSC varies from USD 698 (without a spike) to USD 1 093 (using a log-normal distribution) and the median VSC varies from USD 176 (from the log-normal model) to USD 373 (when including China). The largest deviation of the mean WTP from the baseline estimate is when a log-logistic and log-normal distribution is used, and when survey responses from China are included in the estimation sample. The Weibull distribution was chosen because of a lower AIC score, and as explained previously, the Chinese respondents in this sample are richer than the actual Chinese population.

Table 4.1. Main parametric estimations of WTP to avoid serious kidney disease

	Baseline	Without weights	No spike	Log-logistic	Log-normal	Including China	Excluding Türkiye
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Risk reduction (/ 1 000)	0.122***	0.122***	0.156***	0.165***	0.083***	0.121***	0.126***
	(0.008)	(0.008)	(0.009)	(0.013)	(0.008)	(0.008)	(0.009)
Log(Cost)	- 0.459***	- 0.459***	- 0.602***	- 0.575***	- 0.308***	- 0.461***	- 0.460***
	(0.006)	(0.006)	(0.009)	(0.007)	(0.003)	(0.006)	(0.006)
Spike	0.035***	0.035***		0.024***	0.029***	0.031***	0.036***
	(0.002)	(0.002)		(0.001)	(0.002)	(0.001)	(0.002)
Observations	8 905	8 905	8 905	8 905	8 905	9 709	8 033
Country dummies	No	Yes	No	No	No	No	No
Post-stratification weight x country dummies	Yes	No	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-13 803	-13 800	-11 879	-14 196	-14 408	-14 778	-12 483
LR statistics	354	359	486	315	287	718	290
AIC	27 629	27 622	23 782	28 416	28 840	29 583	24 988
Mean WTP (USD)°	2 609	2 609	2 313	3 394	3 387	3 149	2 453
Median WTP (USD)	764	763	970	744	600	1 258	694
Mean VSC (K USD)°	805	805	698	1 082	1 093	983	753
Median VSC (K USD)	224	223	285	215	176	373	202

Note: The baseline estimation corresponds to a maximum likelihood estimation of the joint probabilities assuming a Weibull distribution with a spike configuration. The baseline sample exclude survey responses from China. All columns exclude survey and valuation speeders as well as respondents who failed the risk tutorial test. Standard errors are given in parentheses. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1. ° integral truncated at maximum bid level with adjustments.

Table 4.2 shows the baseline model with likely determinants of WTP added as additional cofactors. This introduces the potential for multicollinearity, but only three of the independent variables are even weakly correlated (correlation coefficient > 0.2). Below average health is correlated with above average health and no chronic disease (correlation of -0.34 and -0.26, respectively), and high education is correlated with logged income (correlation of 0.22). The statistically significant determinants are the size of the risk reduction, income, and not having another serious disease. Below average health is marginally significant at the 5% level. Cost has a negative effect on the probability of choosing the reduced risk option, and income and the size of the risk reduction have positive impacts. Not being diagnosed with another serious disease has a negative effect on the probability. Surprisingly, people who perceive their own health as below the average of people their age and gender are less likely to choose the reduced risk option. This could capture respondents who have lower preferences for a healthy lifestyle. Gender, education, health insurance, and one's own or a relative's COVID-19 diagnosis have no statistically significant impact on WTP.

To illustrate the impact and relative magnitude of these determinants, marginal effects on the mean WTP are reported in the last column of Table 4.2. The marginal impact for a 0/1 indicator variable was calculated by running the model twice, once with the indicator variable set to zero for all observations and a second time with the indicator variable set to 1, and then recording the change in the mean WTP. The WTP of people who have not been diagnosed with a chronic disease is 15%, or USD 387 lower than the WTP of people who have a chronic disease. Respondents who believe their health is below average would be willing to pay 11%, or USD 279 less. The marginal effect for the continuous variables – risk reduction, logged income, and baseline risk – was calculated by running the model twice, once using the baseline model and a second time increasing the variable by the same amount for all observations. An increase in the risk reduction of 1 in 1 000 for each observation raises the mean WTP by 20%, or USD 518. Increasing the baseline risk for each observation by 1 in 1 000 reduces the mean by a negligible USD 1. An increase in income of USD 500 per month for each observation raises the WTP by 3.6%, or USD 94. Lastly,

increasing the income of every observation by 1% increases the mean WTP by USD 5.32, which is 0.2% of the baseline mean WTP of 2 609, implying an income elasticity of 0.2.

Table 4.2. The determinants of WTP to avoid serious kidney disease

	Baseline	With controls	With health controls	
	Odd ratios	Odd ratios	Odd ratios	Marginal effect (USD)
Risk reduction (/ 1 000)	0.122***	0.123***	0.122***	518°°
	(0.008)	(0.008)	(0.008)	
Log(Income)		0.142***	0.134***	94°°°
		(0.019)	(0.019)	
Missing Income (0/1)		- 0.029	- 0.019	- 74
		(0.041)	(0.042)	
Female (0/1)		- 0.032	- 0.028	- 112
		(0.027)	(0.027)	
High education (0/1)		0.027	0.021	85
		(0.028)	(0.028)	
Baseline risk (/ 1 000)		0.000	0.000	- 1°°
		(0.001)	(0.001)	
Health expenditure out of my pocket (0/1)			- 0.042	- 164
			(0.037)	
Health perceived below average (0/1)			- 0.073*	- 279
			(0.037)	
Health perceived above average (0/1)			0.035	139
			(0.028)	
Relative had kidney failure (0/1)			0.043	173
			(0.027)	
Not diagnosed with chronic diseases (0/1)			- 0.096***	- 387
			(0.028)	
Was diagnosed with COVID-19 (0/1)			0.070	285
			(0.046)	
Relative was diagnosed with COVID-19 (0/1)			0.019	75
			(0.026)	
Log(Cost)	- 0.459***	- 0.460***	- 0.460***	
	(0.006)	(0.006)	(0.006)	
Spike	0.035***	0.034***	0.034***	
	(0.002)	(0.002)	(0.002)	
Observations	8 905	8 905	8 905	
Country dummies	Yes	Yes	Yes	
Log-likelihood	-13 803	-13 767	-13 755	
LR statistics	354	426	450	
AIC	27 629	27 568	27 557	
Mean WTP (USD)°	2 609	2 633	2 637	
Median WTP (USD)	764	788	793	
Mean VSC (K USD)°	805	813	815	
Median VSC (K USD)	224	231	233	

Note: The baseline estimation corresponds to a maximum likelihood estimation of the joint probabilities assuming a Weibull distribution with a spike configuration. The baseline sample exclude survey responses from China. All columns exclude survey and valuation speeders as well as respondents who failed the risk tutorial test. Standard errors are given in parentheses. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1. ° integral truncated at maximum bid level with adjustments. °° Marginal effects as a result of a 1/1000 increase in risk reduction or baseline risk reduction for each observation. °°° Marginal effects as a result of a USD 500 per month increase in in baseline income for each observation.

4.2. Additional robustness checks

The baseline estimation results are also robust to different screening choices, as shown in Table 4.3. When excluding respondents who thought that the change in the risk was, the mean VSC equals USD 806 000, as in column (9). This is almost exactly the same as the baseline estimate of USD 805 000. Removing co-benefiters, respondents who considered changes in other health issues not described in the survey, slightly reduces the VSC to USD 796 000. When people who responded yes to both valuation questions and who indicated that they strongly agree that they would pay almost anything to reduce their risk (the yea-sayers) are removed from the estimation sample, the mean VSC equals USD 806 000. Excluding all people who indicated that they strongly agree that they would pay almost anything to reduce their risk, which is more restrictive than removing the yea-sayers, barely shifts the mean VSC to USD 805 000. Finally, removing protest responses, defined as those who strongly disagree that the survey gave the sufficient information to decide or that did not answer as they would in real life reduced the mean VSC to 804 000. Overall, the WTP and VSC estimates from these different screenings is effectively the same as the baseline estimate.

Table 4.3. Robustness checks of the screening strategy

	Baseline	Excluding respondents who thought change was permanent	Excluding co-benefiters	Excluding yea- sayers	Excluding people who would pay anything	Excluding protest responses
	(8)	(9)	(10)	(11)	(12)	(13)
Risk reduction (/ 1 000)	0.122***	0.120***	0.123***	0.119***	0.119***	0.124***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Log(Cost)	- 0.459***	- 0.460***	- 0.462***	- 0.460***	- 0.460***	- 0.459***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Spike	0.035***	0.034***	0.034***	0.034***	0.034***	0.034***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	8 905	8 418	8 080	8 297	7 882	8 624
Post-stratification weight x country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-13 803	-13 057	-12 479	-12 852	-12 212	-13 378
LR statistics	354	332	337	329	308	350
AIC	27 629	26 138	24 983	25 728	24 449	26 781
Mean WTP (USD)°	2 609	2 607	2 581	2 603	2 601	2 614
Median WTP (USD)	764	766	767	765	765	767
Mean VSC (K USD)°	805	806	796	806	805	804
Median VSC (K USD)	224	225	224	225	225	224

Note: The baseline estimation corresponds to a maximum likelihood estimation of the joint probabilities assuming a Weibull distribution with a spike configuration. The baseline sample exclude survey responses from China. All columns exclude survey and valuation speeders as well as respondents who failed the risk tutorial test. Standard errors are given in parentheses. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1. ° integral truncated at maximum bid level with adjustments.

4.3. Country-level estimates

The parametric estimation results of modelling each country separately are presented in Table 4.4. For all countries, the coefficients have signs and magnitudes that are consistent with result from the baseline model. Scope sensitivity (i.e., the coefficient on risk reduction) is statistically significant for all countries, lowest in Germany and Türkiye, and highest in the United Kingdom and Chile. In all countries, the cost for the reduced risk option (i.e., scale sensitivity) has a negative effect on the probability to choose the reduced risk option and is statistically different from zero.

The highest country-specific mean WTP is USD 8 198 for China, and is a clear outlier. There are various factors that can explain such a high value. First, the median income of the sample of Chinese respondent is three times higher than the median income of the Chinese population, so the mean WTP estimated for China is biased upward given the positive effect of income on WTP. Second, the health system in China likely incentivises Chinese respondents to choose the reduced risk option other things equal. Despite progress in the recent years, China's social security system provides limited protection, and medical bankruptcies pose a serious threat for many households. Insurance for sick leave and for healthcare cost is also uncommon; many Chinese respondents likely have limited or no sick pay and sick leave. In sum, having a chronic disease is more costly for individuals in China than for those in the other countries sampled where the health systems are more protective. When excluding China, the mean (median) WTP varies from USD 1 920 (USD 419) in the United Kingdom to USD 4 046 (USD 1 390) for Türkiye. The small median WTP for Canada is consistent with the high share of respondents who are indifferent to the valued item, shown by the large and statistically significant spike at zero.

Table 4.5 presents the estimation of country-level values using the pooled baseline model. This is the approach agreed upon in the core principles for SWACHE researchers (see 6Annex A). The rationale for this approach is that using the pooled model produces country-level WTP estimates drawn from a single model using the same modelled coefficients. This model includes post-stratification weights times country dummies which not only corrects for the under- or over-representation of individuals in the sample compared to the actual population, but also captures "cultural" differences between the countries. It also increases the statistical power of the country-level estimate. This approach is expected to aid in transferring WTP estimates to countries other than those surveyed.

Country-level estimates of the mean WTP from the pooled baseline model are generated by recovering the individual level WTP estimates for each observation. As described in section 3.2.5, the individual mean WTP is computed by integrating the probability of an individual responding yes to the valuation question over the interval from 0 to the maximum bid, with an adjustment. The country-level mean WTP is the average of the individual mean WTP estimate for all observations from that country. The same approach is used for the median WTP and the VSC estimates.

The country-level results in Table 4.5 are generally consistent with the results in Table 4.4. A country-level estimate is not provided for China because it was not included in the baseline model. The largest impact of using the pooled model is on the estimate for Chile. The mean WTP and VSC increased by over 28% to 3 163 and 994, respectively, and the median values decreased by over 20% to 994 and 292. Most of the other changes in country-level estimates are less than 10%, except for the VSC estimates for the US. The mean (median) WTP varies from USD 1 832 (USD 455) in the United Kingdom to USD 3 870 (USD 1 378) for Türkiye. The mean (median) VSC varies from USD 556 000 (USD 133 000) in the United Kingdom to USD 1 203 000 (USD 401 000) for Türkiye. Following the core principles, we use the results from Table 4.5 as the recommended values for each country.

Table 4.4. Country-specific parametric estimations of WTP to avoid serious kidney disease

	Canada	Chile	China	Denmark	Germany	Italy	Norway	Türkiye	United Kingdom	United States
Risk reduction (/ 1 000)	0.127***	0.148***	0.107**	0.140***	0.095***	0.144***	0.119***	0.087**	0.147***	0.103***
	(0.024)	(0.025)	(0.037)	(0.026)	(0.024)	(0.026)	(0.024)	(0.029)	(0.024)	(0.025)
Log(Cost)	- 0.421***	- 0.708***	- 0.527***	- 0.411***	- 0.462***	- 0.497***	- 0.432***	- 0.447***	- 0.422***	- 0.432***
	(0.015)	(0.025)	(0.030)	(0.016)	(0.017)	(0.019)	(0.016)	(0.020)	(0.015)	(0.016)
Spike	0.049***	0.005***	0.008***	0.051***	0.035***	0.022***	0.043***	0.027***	0.056***	0.048***
	(0.006)	(0.001)	(0.002)	(0.006)	(0.005)	(0.003)	(0.005)	(0.004)	(0.006)	(0.006)
Observations	1 047	981	804	939	1 031	1 022	1 030	872	1 024	959
Log-likelihood	-1 630	-1 518	- 969	-1 458	-1 591	-1 506	-1 668	-1 314	-1 579	-1 445
LR statistics	27	42	12	32	18	33	24	10	38	17
AIC	3 267	3 043	1 946	2 924	3 191	3 020	3 343	2 636	3 167	2 899
Mean WTP (USD)°	2 350	2 462	8 198	2 552	2 297	3 067	2 536	4 046	1 920	2 143
Median WTP (USD)	552	1 253	5 019	611	638	1 080	646	1 390	419	496
Mean VSC (K USD)°	715	771	2 666	764	728	932	782	1 304	565	677
Median VSC (K USD)	158	387	1 552	170	194	311	188	426	116	149

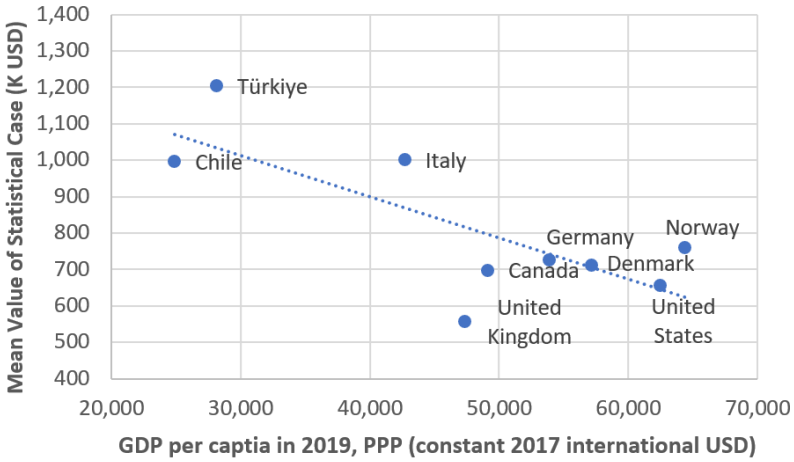
Note: All models correspond to a maximum likelihood estimation of the joint probabilities assuming a Weibull distribution with a spike configuration. All columns exclude survey and valuation speeders as well as respondents who failed the risk tutorial test. Standard errors are given in parentheses. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1. ° integral truncated at maximum bid level with adjustments.

Table 4.5. Estimation of country-level WTP to avoid serious kidney disease using the pooled baseline model

	Canada	Chile	Denmark	Germany	Italy	Norway	Türkiye	United Kingdom	United States
Mean WTP (USD)°	2 277	3 163	2 329	2 358	3 233	2 468	3 870	1 832	2 120
Median WTP (USD)	612	984	631	642	1 016	684	1 378	455	555
Mean VSC (K USD)°	697	994	710	725	1 000	759	1 203	556	655
Median VSC (K USD)	179	292	183	188	297	200	401	133	164

Figure 4.1 displays a scatterplot of the value of statistical case of serious kidney disease from the pooled model (Table 4.5) and the 2019 GDP per capita (PPP, constant 2017 international $) for each country, excluding China. A bivariate regression indicates that GDP is a statistically significant determinant of cross-country differences in the mean VSC (p value = 0.018, Adj. R2 = 0.51). However, preferences for reduced risk of serious kidney disease differ across countries and cannot be predicted by differences in GDP per capita alone. Other factors such as differences in health systems, prevalence of kidney disease, demographic factors such as the pyramid of age or cultural differences might be more relevant, although there were not explicitly tested in this report. Overall, the significant variation in the mean VSC across countries illustrates why eliciting WTP values in various countries is important.

Figure 4.1. Value of Statistical Case of Serious Kidney Disease and GDP per capita



Note: Value of Statistical Case derived from the parametric estimations reported in Table 4.5.
Source: GDP per capita in 2019, PPP (constant 2017 international USD) comes from the World Bank.

5 Recommended values for policy analysis

5.1. Baseline estimate of the value of a statistical case of serious kidney disease

After some consideration, the baseline model reported in Table 4.1 was identified as the preferred model. This baseline specification corresponds to a maximum likelihood estimation of the joint probabilities assuming a Weibull distribution with a spike configuration. Survey responses from China were excluded from the baseline due to the large disparity in the mean income of the sample compared to the population. The estimated mean WTP for reduced risk of experiencing serious kidney disease and the VSC of serious kidney disease using the pooled data equal USD 2 609 and USD 805 000, respectively.

Table 5.1. Recommended value of a statistical case of serious kidney disease by surveyed country

	USD_{2022} PPP	Country currency
Canada	700 000	USD 900 000
Chile	990 000	CLP 401 440 000
Denmark	710 000	DKK 5 170 000
Germany	720 000	EUR 530 000
Italy	1 000 000	EUR 700 000
Norway	760 000	NOK 7 890 000
Türkiye	1 200 000	TRY 2 130 000
United Kingdom	560 000	GBP 420 000
United States	660 000	USD 660 000

Note: Values of a statistical case of chronic kidney disease come from the estimation reported in Table 4.5. The conversions are done using Purchasing Power Parities for actual individual consumption of 2019 since it was used to convert bid levels across countries. Data are provided by the OECD. https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm.

While the pooled values from the baseline model are interesting, the country-specific estimates reported in Table 4.5 and summarised in Table 5.1 are more useful for policy analysis. Preferences for health risk reductions can be expected to vary by country in ways that cannot fully be controlled for in the pooled values. The country-specific values, with the exception of China, reflect the preferences of fairly representative sets of respondents in those countries. Consistency with the principles of cost-benefit analysis requires that benefits be valued as those who are affected would value them, and the country-specific estimates are the best reflection of preferences in each country.

5.2. Strengths and weaknesses of results

This study provides useful and internationally validated estimates of the VSC of serious kidney disease for several countries using an original, state of the art stated preference survey. The survey was administered electronically to samples selected to be demographically representative of each country's population. Using various validity and robustness checks, the survey performs well and as intended. For all countries, the coefficients have signs that are consistent with expectations. Scope sensitivity is statistically significant for all countries. It is smallest in Canada and Türkiye and largest in the United Kingdom and Chile. Comparing the results for the United Kingdom to those reported in Rigby et al. (2017[21]) for a similar endpoint (permanent kidney failure) achieved through a very different pathway, the estimates are an order of magnitude larger. In all countries, the cost for the reduced risk option has a negative effect on the probability to choose the reduced risk option that is statistically different from 0. The statistically significant determinants of WTP include the size of the risk reduction, income, not having another serious disease and below average health.

Although the samples come close to the target quotas on education and age for each country, several country samples missed the mark for other key demographics – most notably the samples from China and Türkiye whose median income was found to be 228% and 162% that of the population, respectively. As reported in Table 5.1 above, the recommended VSC estimate is largest for Türkiye once adjusted by PPP (excluding the VSC for China). Although the income levels for the sample from Türkiye do not differ from the country's population as those from the Chinese sample, they may not adequately reflect the population resulting in potentially higher VSC estimates. Additionally, many countries have an underrepresentation of male respondents and low and medium educated individuals. However, using post-stratification weights as additional regressors allow to control for these deviations from the population.

While the study significantly expands the number of WTP estimates for chronic kidney disease available for policy analysis, many countries are, of course, excluded. Countries without their own country-specific values will need to conduct benefit transfer using best practices.[6] In the absence of benefit transfer guidance specific to the health effects covered by the SWACHE project, it is recommended as a starting point that non-surveyed countries use the value estimated for a surveyed country from Table 5.1 that shares similar characteristics such as income, population by age, and public health care systems.

5.3. How these values improve the ability to measure regulatory benefits

Government authorities continue new efforts to reduce kidney disease and will continue to consider regulations of chemicals, many of which may have chronic non-cancer kidney effects. For example, under the 2016 amendments to the Toxic Substances Control Act, the US EPA is required to continually evaluate risks of existing chemicals, determine whether those risks are unreasonable, and then issue regulations to mitigate unreasonable risks. It is likely that there will be kidney effects associated with some of these chemicals. Regulatory efforts continue to control exposure to biotoxins from pathogens, e.g., the US Food and Drug Administration is implementing irrigation water quality regulations aimed, in part at reducing shiga-toxin producing *E. coli* (STEC) contamination of leafy greens (US FDA, 2022[32]). Economic analysis is often an important consideration in these regulations. To date there have been no WTP estimates for kidney disease that can be used in these economic analyses.

The values developed here provide the basis for a more complete and rigorous characterisation of the benefits of reduced exposure to contaminants associated with the risk of kidney disease. Because the survey was designed without specifying the culprit contaminant or mode of risk reduction, the results can be applied in many contexts including exposures to water and air pollution. The ability of economic

[6] The OECD will publish benefit transfer guidance that can be applied to the SWACHE project.

analyses to quantify and value non-carcinogenic kidney effects will depend upon the ability of risk assessment to provide dose-response functions for these effects. While some studies are available linking chronic kidney disease to air pollution (Bi et al., 2021[33]; Shubham et al., 2022[34]), in the context of chemical exposures where human data limited additional work is likely needed to estimate applicable dose-response functions from animal data. This survey provides a WTP for a well-defined endpoint for risk assessments to model as data allow.

5.4. Using the value of a statistical case of chronic kidney disease in cost benefit analysis

The obtained VSC estimates for chronic kidney disease from Table 5.1 can be used in cost-benefit analyses addressing proposed regulations of chemicals or other pollutants that negatively affects kidney disease as follows.

Assume a policy is appraised over T years in country c. Compared to the status quo, this policy is estimated to lead to a reduction of SC_{ct} statistical cases of chronic kidney disease in country c in year t. The discounted benefits of the policy in terms of avoided chronic kidney disease should be computed as follows:

$$Discounted\ benefits_c = \sum_{t=0}^{T} \frac{VSC_{ct} \times SC_{ct}}{(1+k_c)^t} \quad (1)$$

where k_c is the discount rate used in country c[7], VSC_{ct} is the recommended value of a statistical case of chronic kidney disease in country c in year t. VSC_{ct} are based on the recommended values $VSC_{c,2022}$ reported in USD PPP in Table 5.1 and should reflect increase in prices and in GDP per capita over time such that:

$$VSC_{ct} = VSC_{c,2022} \times PPP_{c,2019} \times \left(1 + \%\Delta P_{c,2022-t}\right) \times \left(1 + \%\Delta Y_{c,2022-t}\right)^{\beta} \quad (2)$$

where $PPP_{c,2022}$ stands for Purchasing Power Parity for actual individual consumption in national currency per USD for the year 2019 that was used to convert the bid levels in the survey, $\%\Delta P_{c,2022-t}$ is the increase in consumer price index from 2022 to year t, $\%\Delta Y_{c,2022-t}$ is GDP per capita growth from 2022 to year t and β is the income elasticity.

An illustrative example for a fictional policy that reduces the number of statistical cases of serious kidney disease by 1 000 every year in the United Kingdom for 2022-2025 is provided in Table 5.2. Based on a VSC of USD 560 000 in 2022, the discounted benefits of the policy over the 4 years equals GBP_{2022} 1.7 billion.

Finally, the discounted costs of the policy should be subtracted from these discounted benefits to compute the net present value of the policy.

[7] Note that the discount rate may vary over time, but is generally stable over shorter horizons.

Table 5.2. Measuring the benefits of policy intervention in the United Kingdom: an illustrative example using the value of a statistical case of chronic kidney disease

Year		2022	2023	2024	2025
GDP per capita, volume in USD, at constant PPP (USD_{2015})		44 229	43 898	43 844	43 871[a]
GDP per capita growth since 2022 ($\%\Delta Y_{c,2022-t}$)			-0.75%	-0.87%	-0.81%[a]
Consumer Price Index (2015)		121	125[b]	129[b]	133[b]
Consumer Price Index growth since 2022 ($\%\Delta P_{c,2022-t}$)			3.32%[b]	6.64%[b]	9.96%[b]
PPP for actual individual consumption ($PPP_{c,2019}$)		0.75			
Value of a Statistical Case of Chronic Kidney Disease (VSC)	(USD_{2022} PPP thousand)	560			
	(GBP_{2022} thousand)	419			
	(GBP thousand)	419	391	404	416
Annual statistical cases of chronic kidney disease avoided (SC_{ct})		1 000	1 000	1 000	1 000
Discounted annual benefits (GBP_{2022} million)		419	417	416	415
Discount rate		3.5%[c]	3.5%	3.5%	3.5%
Discounted benefit (GBP_{2022} million)		1 667			

Note: This illustrative example assumes a fictional policy that would reduce the number of statistical cases of chronic kidney disease by 1 000 every year in the United Kingdom from 2022 to 2025. GDP per capita projections for 2022-2024 are provided by the OECD Economic Outlook (2022[35]). [a]GDP per capita for 2025 is computed by the authors based on the linear fit of 2022-2024 values over time and is not an OECD forecast. Consumer Price Index data for 2022 comes from the OECD Dataset: Consumer price indices (CPIs) as of January 2022. [b]a 4% increase per year is assumed for Consumer Price Index for 2023-2025 and is not an OECD forecast. PPP for actual individual consumption data is for year 2019 as used to convert bid levels across countries and comes from the OECD Dataset: PPPs and exchange rates as of January 2022. [c]The discount rate comes from HM Treasury's Green Book (2022[36]) and is what is used in the United Kingdom for assessment period from 0 to 30 years. The income elasticity equals 0.2 as estimated in this paper.

6 Conclusion

This study had as its goal the derivation of internationally validated willingness-to-pay estimates for reduced risk of serious kidney disease – a potential health outcome associated with exposures to chemicals and other contaminants. Using a state of the art, original survey instrument, the WTP estimates was elicited from 12 000 individuals in 10 countries. The present study derived individual country estimates of the VSC of chronic kidney disease for use in policy analyses by applying well-established empirical models to the 8 905 complete, valid and verified responses. The estimates proved to be robust to alternative methodological and screening choices. Additionally, empirical results were consistent with theoretical expectations both in aggregate and at the country-level.

The estimates provided by this paper are for kidney disease characterised in a manner that is most likely to synchronise with risk estimates that emerge from scientific research and applied human health risk assessment. These estimates are not limited to the “worst case” of kidney failure but are for symptomatic chronic kidney disease with the chance that it may result in kidney failure. As such, they are more representative of chronic kidney disease likely to be experienced from exposure to toxic chemicals. Because the description of severe kidney disease used in the survey includes reduced life expectancy among the listed adverse effects, the results should not be combined with any WTP values for reduced risk of fatality associated with kidney disease. To add these results together would result in double-counting.

Specific country estimates follow a common elicitation method that meets current methodological standards for stated preference studies and provide estimates that may be directly used for applied cost-benefit analysis in those countries. Use in other countries may benefit from benefit-transfer methods and the survey facilitates this by employing, as much as possible, a consistent survey approach and empirical method across all countries.

Looking forward, this study, in conjunction with the other surveys conducted under the SWACHE project, is likely to be informative for designing and implementing future cross-country surveys. For example, the survey shows that substantive survey revisions in addition to translation verification are likely to be necessary for a successful survey implementation in some countries. It may be the case that the results for China in this survey are due to language issues contributing to completion time anomalies, and more work may be needed for testing and refining the instrument after translating to mitigate such issues. Additionally, while the results of this survey are robust, it would be valuable to have multiple estimates of kidney disease under various approaches. For example, this survey adopted the approach of a broad sample who were provided a description of kidney disease, it may be useful to compare these results with a study sample of those more familiar with kidney disease and its consequences (e.g., those who have family members who have suffered from it.). Finally, benefit-transfer both across countries and across health endpoints can be more fully evaluated using this study and those for other endpoints conducted under the SWACHE effort.

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Annex A. Core principles of survey analysis

Detect potentially problematic Detect potentially problematic responses

1. Generate a dummy variable for people failing the probability test
2. Speeder management: Generate one dummy variable for *survey* speeders and one dummy for *valuation* speeder. A respondent taking less than 48% of the median time is a speeder (ISS definition). Median values should be country specific to account for difference in languages that impact reading time.
3. Generate two dummies variable for distracted respondents: respondents who took an abnormally long time to respond:
    a. 48% longer than the median *survey* time,
    b. 48% longer than the median *valuation* time.
4. Optional. Generate a dummy variable for straightliners: when survey respondents give identical (or nearly identical) answers to items in a battery of questions using the same response scale. Note that there should not be any of them in the data sent by the internet panel provider.
5. Optional. Generate a dummy variable for respondents having incoherent answers:
    a. E.g., mismatch between the number of children, number of people in the household, or year of youngest child
6. Generate a dummy variable for unrealistic max WTP in open-ended question
7. Generate a dummy variable for probability test failers
8. Generate a dummy variable for protesters. This varies between endpoints. For example, in the asthma survey, people who disagree with the description of asthma provided in the survey or who are very doubtful that the information provided by the survey is correct or who thought they could just lower consumption of cleaning products can be considered as protesters.
9. Generate a dummy variable for respondents stating high co-benefits
10. Generate a dummy variable for consequentiality (real life debrief)
11. Optional. Read written responses to open ended questions to detect potentially problematic responses
12. Optional. Compute number of problematic responses to debriefing:
    a. that could overestimate WTP
    b. that could underestimate WTP
    c. that could go in either direction or a non-directional

Screen out problematic responses

- Baseline:
  - Exclude survey and valuation speeder (reinforced compared to Ipsos)
  - Exclude straightliners (already done by Ipsos)
  - Exclude respondents who fail the probability test (not applicable for IQ loss)
  - Keep pilot respondents if the survey design is the same even if parameters (such as bid levels) changed except if the changes are significant
  - Keep co-benefiters
  - Keep protesters to have a conservative estimate
  - Keep distracted respondents
  - Variations to perform as robustness checks:
- Optional robustness: stricter screening
  - Exclude survey and valuation speeder (same as option A)
  - Exclude straightliners (same as option A)
  - Exclude respondents who fail the probability test (same as option A)
  - Keep pilot respondents if the survey design is the same even if parameters (such as bid levels) changed (same as option A)
  - Keep co-benefiters (same as option A)
  - Exclude protesters because no does not mean true zero
  - Exclude distracted respondents
  - Exclude pilot respondents if pilot parameters differ too much (case of VLBW)
- Optional: exclude respondents that took more than 12h to complete the survey

Provide information on the sample of respondents

1. Compute summary statistics to describe the screened sample
   - Put main descriptive in body of text
   - And other e.g., country level in the appendix
2. Check that achieved quotas (age, education, location, gender) and income distribution in the screened sample are consistent with available population statistics (target quotas) at the country level (from OECD.Stat and Eurostat).
3. For each country separately, compute post-stratification weights to reweight later the observations through an iterative proportional fitting procedure (raking algorithm) using the following strata:
   - Gender × Age: (1) males aged 18-24; (2) males aged 25-34; (3) males aged 35-39; (4) males aged 40-44; (5) males aged 45-65; (6) females aged 18-24; (7) females aged 25-34; (8) females aged 35-39; (9) females aged 40-44.
   - Educational level: (1) low, (2) medium, and (3) high
   - Geographic region: country-specific NUTS 2 regions

It is important to consider the efficiency of the weights, such that ideally the overall weighting efficiency remains above a certain value to avoid any significant impact on the effective sample sizes obtained and,

consequently, on the statistical power of the analyses conducted. Weighting efficiency can be further improved by collapsing weighting cells and capping weights at each of the steps to reduce the impact on the variance of the final weights. At the end of each iteration of the algorithm, any weights larger than 3.0 or lower than 1/3 should be automatically set to equal this cap.

Analyse responses to the valuation questions after baseline screening

1. Compute the DBDC response matrix for both the pooled dataset and each country of the dataset
2. Scope analysis:
   - Verify that the share of yes response decreases with the cost to be paid
   - Verify that the share of yes response increases with the risk reduction offered
3. Analyse written (open-ended) questions:
   - Use examples to illustrate the thinking of respondents if they were asked why they made their choice
   - Optional. Check consistency between OE and DBDC responses
4. As a preliminary step, regress SBDC (response to first dichotomous choice) on income, bid amount, baseline risk (if relevant) and risk reduction using a logit model
5. Optional. Try to find determinants of no-no and yes-yes responses using responses to debriefing questions

Compute harmonised variables

1. Compute continuous income level in USD PPP[8] based on unequivalised income range selected by the respondents:
   - Average of each interval
   - 0.5 lowest interval and 1.5 highest interval
2. Predict missing income using the following strategy
   - Generate the following dummies
     - Missing income dummy equal to 1 if the respondent did not provide income information
     - Couple dummy equals 1 if the respondent is married or have a partner
     - Employed dummy equals 1 if the respondent is in one of the following situations:
       - employed full-time
       - self employed
       - military
       - Own business manager
     - Part time dummy equals 1 if the respondent is employed part time

[8] This is OECD standard. PPS is the technical term used by Eurostat for the common currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the euro.

- Retired dummy equals 1 if the respondent is retired
- Replace employed and part time dummies by 0 if they are missing
- Replace retired dummy by 1 if it is missing and the person is aged 60 or more or by 0 if it is missing and the person is younger than 60 years old.

- For each surveyed country separately, run the OLS regression of log(income) on age dummies, high education dummy, female dummy, couple dummy, number of persons in the household, employed dummy, part time dummy and retired dummy. For surveys targeting couples planning to have children, do not include couple dummy nor retired dummy that are naturally omitted since perfectly colinear.
- Predict income based on the regressions
- Replace missing income with predicted value in the main dataset

3. Compute a variable for age:
   - Option A (preferred). One dummy variable for each category ➔ better identification
   - Option B. Continuous age as for income ➔ preserves statistical power
     - 18-26 ➔22
     - 27-34 ➔ 30.5
     - 35-39 ➔37
     - 40-44 ➔ 42
     - 45-65 ➔ 55
     - 65+ ➔ 70
4. Compute a variable for education using Ipsos's low, medium and high category (directly available)
5. For all countries except the United States, compute bid level in USD PPP equivalent using OECD data on PPP for actual individual consumption. Because of rounding after currency conversion, respondents in non-US countries had bid levels that are slightly different than the bid levels seen by US respondents. Reconverting actual bid levels to USD PPP equivalent allows to obtain a more precise bid amount.

Apply a standard specification

1. Baseline:
   - All surveys: intercept, female, age, kids02, category dummies, log(income), missing income dummy, low, medium, high education dummies, baseline risk (if relevant), risk reduction
   - Add country dummies interacted by the post stratification weights to account for the difference between target and achieved sample quotas. This is similar to—albeit less complex than—the correction method for choice-based samples proposed by Manski and Lerman (1977[37]). Do not add country dummies to these interactions to avoid multi collinearity.
   - Add the number of children for fertility loss and VLBW
2. Robustness checks:
   - Health augmentation: own health perception, know someone having the condition, lifestyle, covid

- Run the estimation without the missing income dummy.

Estimate average and median WTP based on DBDC

1. Estimator: DBDC or SBDC:
   - Baseline: interval-data maximum likelihood estimator using DBDC
   - Robustness check: Estimate WTP based on SB choice with logit model to compare to DB estimate
2. Distribution of the error:
   - Baseline (preferred to allow comparison across endpoints): Weibull. The Weibull distribution has desirable characteristics. Specifically, this specification offers a flexible survival function which mimics other distributional forms quite well, and thanks to its shorter right tail it typically performs better than the log-normal distribution (Carson and Hanneman, 2005[28]).
   - Robustness checks:
     - Non-parametric: Turnbull (e.g., Kaplan-Meier)
     - Basic parametric: normal, log normal, logistic, log logistic
     - Identify estimator with the lowest Akaike information criterion ($AIC = 2k - 2\ln\hat{L}$)
3. Spike configuration:
   - Baseline: use spike configuration (Kriström, 1997[31]; Carson and Hanneman, 2005[28]) if the spike variable is higher or equal to 5%. In other words, use spike when the average probability that people are indifferent to the valued item is higher or equal to 5%. Spike configuration can still be used if spike is lower than 5% but close to it. Spike is less likely to be relevant when people that have a priori no preference for the good are screened out by design. This is the case of the infertility and VLBW where only people planning to have a child over the next years were able to respond to the survey.
   - Robustness check: Compare estimates using spike and without using spike.
4. Compute WTP and VSC on pooled dataset based on a simple model with constant, country dummies interacted with weights and risk reduction as the only covariates using the following formulas:
   - Baseline: $\widehat{VSC} = \frac{1}{n}\sum_i \widehat{VSC_i}$ where $\widehat{VSC_i} = \widehat{WTP_i}/RR_i$ and $\widehat{WTP_i}$ is the individual mean WTP (truncated at the maximum bid with adjustment)
   - Robustness check (optional): Compute average WTP at sample mean: $\widehat{\overline{WTP}} = \widehat{b_0} + \widehat{b_1}\overline{RR} \rightarrow \widehat{VSC} = \widehat{\overline{WTP}}/\overline{RR}$
5. Compute WTP and VSC for each country based on the ***pooled*** regression estimated above. Do not use separate country-level regressions to generate country-level WTP and VSC as indicated in the previous version. Using the pooled model allows to capture the "cultural" differences between the countries (by also taking into account the fact that the sample is not perfectly representing the population in the country), by multiplying the country dummies with the weights, and using this as a coefficient to predict the values in each country. The pooled approach also increases dramatically the statistical power.
6. Perform the estimation using the standard specification defined above to test determinants of WTP:

- Assess scope sensitivity:
  - Inference of the risk reduction coefficient
  - Optional. Estimate WTP for different risk reduction separately
- Estimate income elasticity by simulating an increase in income by 1% for all respondents.
  - Increase income of all respondents by 1% before computing individual WTP. This relies on the same estimates derived from original data.
  - Compute the new mean of the individual mean WTP (truncated at the maximum bid with adjustment)
  - The elasticity is equal to this % change between this new mean and the baseline mean WTP.
- Other effects using the regressors of the specification: age, gender, etc.

Derive central value and range of VSC for pooled dataset and each country

1. Estimate central value (mean VSC) using the baseline approach. The central value should be clearly identified for regulators to choose.
2. Clearly present country-specific values as recommended values because they can be directly use in cost benefit analyses.
3. Provide pooled (all countries) mean VSC for information.
4. Provide pooled and country specific median WTP and VSC in the appendix
5. Provide an example of how the VSC can be used in CBA.
6. Compare WTP and VSC with magnitude of available WTP, QALY and Cost-of-Illness estimates from the literature for similar endpoints.

Prepare and share your code

1. Baseline: Prepare your code in R because it is free and more flexible (see dbchoice and dbspike packages). In contrast, only interval data ML estimators based on normal distribution are directly available for Stata (intreg, doubleb). In the long run, it is planned to make the code of the working paper publicly available.
2. Comment your code sufficiently so that a third person can run your code from scratch.
3. Share your code in shared folders.

Annex B. Country-Specific Summary Statistics

Canada

Table B.1. Summary statistics for continuous variables – Canada

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	1 047	20.9	15.7	19.7	7.3	198.7
Time for 1st dichotomous choice question (seconds)	1 047	24.6	18	34.4	6	737
Time for 2nd dichotomous choice question if first response was No (Current risk)	372	29.0	8	311.8	2	5993
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	676	11.5	9	13.2	2	197
Total time to complete both valuation questions (seconds)	1 047	42.3	28	189.3	13	6004
Cost over 5 years for 1st dichotomous choice question (in USD)	1 047	1 716	1 208	1 430	322	4 834
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	1 047	1 670	1 128	2 007	161	9 667
Baseline Risk	1 047	31.4	25	18.0	15	60
Monthly household income (in USD)	916	4 851	3 706	3 671	926	13 656
Monthly household income (w/ predicted, in USD)	1 047	4 727	3 706	3 483	926	13 656

Table B.2. Summary statistics for indicator variables - Canada

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	109	10.4%
Age 27-34	129	12.3%
Age 35-39	94	9.0%
Age 40-44	107	10.2%
Age 45-59	323	30.9%
Age 60-65	91	8.7%
Age 65+	194	18.5%
Female	616	58.8%
Respondents who said Yes-Yes to pay for risk reductions	235	22.4%
Respondents who said No-No to pay for risk reductions	463	44.2%
Respondents who said Yes-No to pay for risk reductions	136	13.0%
Respondents who said No-Yes to pay for risk reductions	213	20.3%
Respondents with a high level of education	532	50.8%
Health expenditures are out of respondent's own pocket	96	9.2%
Health perceived as below average or did not answer	148	14.1%
Health perceived as above average	477	45.6%
Relative or friend had kidney failure	385	36.8%
Respondents who have never been diagnosed with a chronic disease	692	66.1%
Respondents who have been diagnosed with COVID-19	31	3.0%
A close friend or family member was diagnosed with COVID-19	336	32.1%
Respondents who thought the risk reduction was permanent	59	5.6%
Respondents who considered other health issues (co-benefits)	138	13.2%
Respondents who strongly agreed they would pay almost anything to reduce risks	89	8.5%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	47	4.5%
Protesters: Did not answer as in real life, or did not have enough information	39	3.7%

Chile

Table B.3. Summary statistics for continuous variables - Chile

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	981	26.2	20.2	23.5	9.4	361.2
Time for 1st dichotomous choice question (seconds)	981	47.3	35	78.5	9	1946
Time for 2nd dichotomous choice question if first response was No (Current risk)	470	23.6	10	230.5	3	5006
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	520	15.3	10.5	42.9	3	927
Total time to complete both valuation questions (seconds)	981	66.6	48	181.1	22	5029
Cost over 5 years for 1st dichotomous choice question (in USD)	981	1 661	1 194	1 381	311	4 802
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	981	1 946	1 194	2 160	155	9 604
Baseline Risk	981	24.8	15	15.3	15	60
Monthly household income (in USD)	944	2 186	1 744	1 722	263	7 239
Monthly household income (w/ predicted, in USD)	981	2 164	1 744	1 702	263	7 239

Table B.4. Summary statistics for indicator variables - Chile

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	180	18.3%
Age 27-34	235	24.0%
Age 35-39	115	11.7%
Age 40-44	75	7.6%
Age 45-59	231	23.5%
Age 60-65	60	6.1%
Age 65+	85	8.7%
Female	551	56.2%
Respondents who said Yes-Yes to pay for risk reductions	236	24.1%
Respondents who said No-No to pay for risk reductions	274	27.9%
Respondents who said Yes-No to pay for risk reductions	231	23.5%
Respondents who said No-Yes to pay for risk reductions	240	24.5%
Respondents with a high level of education	281	28.6%
Health expenditures are out of respondent's own pocket	190	19.4%
Health perceived as below average or did not answer	142	14.5%
Health perceived as above average	371	37.8%
Relative or friend had kidney failure	483	49.2%
Respondents who have never been diagnosed with a chronic disease	612	62.4%
Respondents who have been diagnosed with COVID-19	143	14.6%
A close friend or family member was diagnosed with COVID-19	533	54.3%
Respondents who thought the risk reduction was permanent	69	7.0%
Respondents who considered other health issues (co-benefits)	135	13.8%
Respondents who strongly agreed they would pay almost anything to reduce risks	201	20.5%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	74	7.5%
Protesters: Did not answer as in real life, or did not have enough information	84	8.6%

China

Table B.5. Summary statistics for continuous variables - China

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	804	19.4	15.2	15.4	6.8	185.6
Time for 1st dichotomous choice question (seconds)	804	45.9	20	201.6	3	5331
Time for 2nd dichotomous choice question if first response was No (Current risk)	564	13.3	7	34.0	1	654
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	241	12.7	6	29.5	2	300
Total time to complete both valuation questions (seconds)	804	59.0	28	204.5	11	5334
Cost over 5 years for 1st dichotomous choice question (in USD)	804	1 707	1 197	1 372	239	4 789
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	804	2 510	1 437	2 449	120	9 579
Baseline Risk	804	23.8	25	13.2	15	60
Monthly household income (in USD)	799	3 290	2 754	1 330	48	4 562
Monthly household income (w/ predicted, in USD)	804	3 280	2 754	1 331	48	4 562

Table B.6. Summary statistics for indicator variables - China

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	128	15.9%
Age 27-34	151	18.8%
Age 35-39	109	13.6%
Age 40-44	91	11.3%
Age 45-59	242	30.1%
Age 60-65	73	9.1%
Age 65+	10	1.2%
Female	414	51.5%
Respondents who said Yes-Yes to pay for risk reductions	472	58.7%
Respondents who said No-No to pay for risk reductions	138	17.2%
Respondents who said Yes-No to pay for risk reductions	91	11.3%
Respondents who said No-Yes to pay for risk reductions	103	12.8%
Respondents with a high level of education	151	18.8%
Health expenditures are out of respondent's own pocket	72	9.0%
Health perceived as below average or did not answer	136	16.9%
Health perceived as above average	293	36.4%
Relative or friend had kidney failure	147	18.3%
Respondents who have never been diagnosed with a chronic disease	616	76.6%
Respondents who have been diagnosed with COVID-19	2	0.2%
A close friend or family member was diagnosed with COVID-19	15	1.9%
Respondents who thought the risk reduction was permanent	21	2.6%
Respondents who considered other health issues (co-benefits)	59	7.3%
Respondents who strongly agreed they would pay almost anything to reduce risks	149	18.5%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	122	15.2%
Protesters: Did not answer as in real life, or did not have enough information	11	1.4%

Denmark

Table B.7. Summary statistics for continuous variables - Denmark

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	939	18.3	15.1	15.1	6.9	224.6
Time for 1st dichotomous choice question (seconds)	939	25.4	18	62.7	4	1243
Time for 2nd dichotomous choice question if first response was No (Current risk)	362	9.9	8	7.4	2	66
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	578	10.2	8	9.6	2	149
Total time to complete both valuation questions (seconds)	939	35.5	28	63.9	12	1257
Cost over 5 years for 1st dichotomous choice question (in USD)	939	1 712	1 233	1 417	274	4 795
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	939	1 691	1 096	1 926	137	9 590
Baseline Risk	939	34.4	25	18.9	15	60
Monthly household income (in USD)	814	4 169	3 562	2 656	952	10 378
Monthly household income (w/ predicted, in USD)	939	4 099	3 562	2 541	952	10 378

Table B.8. Summary statistics for indicator variables - Denmark

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	119	12.7%
Age 27-34	74	7.9%
Age 35-39	51	5.4%
Age 40-44	76	8.1%
Age 45-59	297	31.6%
Age 60-65	93	9.9%
Age 65+	229	24.4%
Female	445	47.4%
Respondents who said Yes-Yes to pay for risk reductions	227	24.2%
Respondents who said No-No to pay for risk reductions	408	43.5%
Respondents who said Yes-No to pay for risk reductions	135	14.4%
Respondents who said No-Yes to pay for risk reductions	169	18.0%
Respondents with a high level of education	417	44.4%
Health expenditures are out of respondent's own pocket	148	15.8%
Health perceived as below average or did not answer	218	23.2%
Health perceived as above average	333	35.5%
Relative or friend had kidney failure	234	24.9%
Respondents who have never been diagnosed with a chronic disease	531	56.5%
Respondents who have been diagnosed with COVID-19	59	6.3%
A close friend or family member was diagnosed with COVID-19	309	32.9%
Respondents who thought the risk reduction was permanent	69	7.3%
Respondents who considered other health issues (co-benefits)	70	7.5%
Respondents who strongly agreed they would pay almost anything to reduce risks	80	8.5%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	55	5.9%
Protesters: Did not answer as in real life, or did not have enough information	19	2.0%

Germany

Table B.9. Summary statistics for continuous variables - Germany

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	1 031	19.4	15.1	17.4	7.0	277.3
Time for 1st dichotomous choice question (seconds)	1 031	29.7	20	69.9	6	1508
Time for 2nd dichotomous choice question if first response was No (Current risk)	421	12.1	8	21.6	2	316
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	610	28.4	8	446.3	2	11032
Total time to complete both valuation questions (seconds)	1 031	51.4	30	350.2	14	11041
Cost over 5 years for 1st dichotomous choice question (in USD)	1 031	1 601	1 208	1 320	268	4 564
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	1 031	1 605	1 074	1 770	134	9 129
Baseline Risk	1 031	30.7	25	17.8	15	60
Monthly household income (in USD)	954	4 016	3 692	2 461	738	10 272
Monthly household income (w/ predicted, in USD)	1 031	3 986	3 692	2 428	738	11 325

Table B.10. Summary statistics for indicator variables - Germany

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	108	10.5%
Age 27-34	139	13.5%
Age 35-39	92	8.9%
Age 40-44	95	9.2%
Age 45-59	331	32.1%
Age 60-65	74	7.2%
Age 65+	192	18.6%
Female	549	53.2%
Respondents who said Yes-Yes to pay for risk reductions	250	24.2%
Respondents who said No-No to pay for risk reductions	422	40.9%
Respondents who said Yes-No to pay for risk reductions	171	16.6%
Respondents who said No-Yes to pay for risk reductions	188	18.2%
Respondents with a high level of education	323	31.3%
Health expenditures are out of respondent's own pocket	20	1.9%
Health perceived as below average or did not answer	197	19.1%
Health perceived as above average	411	39.9%
Relative or friend had kidney failure	254	24.6%
Respondents who have never been diagnosed with a chronic disease	660	64.0%
Respondents who have been diagnosed with COVID-19	47	4.6%
A close friend or family member was diagnosed with COVID-19	288	27.9%
Respondents who thought the risk reduction was permanent	53	5.1%
Respondents who considered other health issues (co-benefits)	62	6.0%
Respondents who strongly agreed they would pay almost anything to reduce risks	95	9.2%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	66	6.4%
Protesters: Did not answer as in real life, or did not have enough information	18	1.7%

Italy

Table B.11. Summary statistics for continuous variables - Italy

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	1 022	17.5	13.8	14.1	6.3	183.1
Time for 1st dichotomous choice question (seconds)	1 022	30.6	20	80.2	3	1663
Time for 2nd dichotomous choice question if first response was No (Current risk)	469	8.9	7	6.1	2	48
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	553	9.8	7	16.7	2	323
Total time to complete both valuation questions (seconds)	1 022	40.0	29	81.3	13	1669
Cost over 5 years for 1st dichotomous choice question (in USD)	1 022	1 706	1 265	1 400	281	4 779
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	1 022	1 891	1 124	2 156	141	9 558
Baseline Risk	1 022	28.6	25	16.6	15	60
Monthly household income (in USD)	897	3 241	2 671	1 998	633	10 333
Monthly household income (w/ predicted, in USD)	1 022	3 148	2 671	1 905	633	10 333

Table B.12. Summary statistics for indicator variables - Italy

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	127	12.4%
Age 27-34	151	14.8%
Age 35-39	92	9.0%
Age 40-44	92	9.0%
Age 45-59	350	34.2%
Age 60-65	68	6.7%
Age 65+	142	13.9%
Female	561	54.9%
Respondents who said Yes-Yes to pay for risk reductions	317	31.0%
Respondents who said No-No to pay for risk reductions	369	36.1%
Respondents who said Yes-No to pay for risk reductions	152	14.9%
Respondents who said No-Yes to pay for risk reductions	184	18.0%
Respondents with a high level of education	216	21.1%
Health expenditures are out of respondent's own pocket	221	21.6%
Health perceived as below average or did not answer	116	11.4%
Health perceived as above average	271	26.5%
Relative or friend had kidney failure	390	38.2%
Respondents who have never been diagnosed with a chronic disease	759	74.3%
Respondents who have been diagnosed with COVID-19	80	7.8%
A close friend or family member was diagnosed with COVID-19	400	39.1%
Respondents who thought the risk reduction was permanent	66	6.5%
Respondents who considered other health issues (co-benefits)	85	8.3%
Respondents who strongly agreed they would pay almost anything to reduce risks	102	10.0%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	57	5.6%
Protesters: Did not answer as in real life, or did not have enough information	23	2.3%

Norway

Table B.13. Summary statistics for continuous variables - Norway

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	1 030	19.6	15.5	16.9	7.2	193.3
Time for 1st dichotomous choice question (seconds)	1 030	30.0	21	69.3	6	1543
Time for 2nd dichotomous choice question if first response was No (Current risk)	421	10.7	8	24.5	2	498
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	609	13.9	9	57.0	3	1236
Total time to complete both valuation questions (seconds)	1 030	42.5	30	83.6	14	1555
Cost over 5 years for 1st dichotomous choice question (in USD)	1 030	1 697	1 153	1 413	288	4 803
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	1 030	1 796	1 153	2 137	144	9 607
Baseline Risk	1 030	30.6	25	17.9	15	60
Monthly household income (in USD)	891	4 853	4 563	2 835	1 057	12 105
Monthly household income (w/ predicted, in USD)	1 030	4 762	4 563	2 718	1 057	12 105

Table B.14. Summary statistics for indicator variables - Norway

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	142	13.8%
Age 27-34	118	11.5%
Age 35-39	95	9.2%
Age 40-44	113	11.0%
Age 45-59	296	28.7%
Age 60-65	75	7.3%
Age 65+	191	18.5%
Female	520	50.5%
Respondents who said Yes-Yes to pay for risk reductions	244	23.7%
Respondents who said No-No to pay for risk reductions	409	39.7%
Respondents who said Yes-No to pay for risk reductions	177	17.2%
Respondents who said No-Yes to pay for risk reductions	200	19.4%
Respondents with a high level of education	540	52.4%
Health expenditures are out of respondent's own pocket	225	21.8%
Health perceived as below average or did not answer	222	21.6%
Health perceived as above average	340	33.0%
Relative or friend had kidney failure	320	31.1%
Respondents who have never been diagnosed with a chronic disease	625	60.7%
Respondents who have been diagnosed with COVID-19	23	2.2%
A close friend or family member was diagnosed with COVID-19	249	24.2%
Respondents who thought the risk reduction was permanent	45	4.4%
Respondents who considered other health issues (co-benefits)	60	5.8%
Respondents who strongly agreed they would pay almost anything to reduce risks	33	3.2%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	24	2.3%
Protesters: Did not answer as in real life, or did not have enough information	20	1.9%

Türkiye

Table B.15. Summary statistics for continuous variables - Türkiye

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	872	19.9	16.4	16.1	7.4	239.9
Time for 1st dichotomous choice question (seconds)	872	36.4	26	52.3	3	783
Time for 2nd dichotomous choice question if first response was No (Current risk)	455	10.4	8	8.7	2	81
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	417	11.7	8	27.7	2	546
Total time to complete both valuation questions (seconds)	872	47.5	35.5	56.7	16	789
Cost over 5 years for 1st dichotomous choice question (in USD)	872	1 678	1 226	1 370	279	4 794
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	872	2 091	1 226	2 328	139	9 589
Baseline Risk	872	21.4	15	9.7	15	60
Monthly household income (in USD)	849	3 710	3 457	2 159	362	7 443
Monthly household income (w/ predicted, in USD)	872	3 686	3 457	2 139	362	7 443

Table B.16. Summary statistics for indicator variables - Türkiye

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	179	20.5%
Age 27-34	145	16.6%
Age 35-39	130	14.9%
Age 40-44	116	13.3%
Age 45-59	263	30.2%
Age 60-65	34	3.9%
Age 65+	5	0.6%
Female	430	49.3%
Respondents who said Yes-Yes to pay for risk reductions	322	36.9%
Respondents who said No-No to pay for risk reductions	274	31.4%
Respondents who said Yes-No to pay for risk reductions	133	15.3%
Respondents who said No-Yes to pay for risk reductions	143	16.4%
Respondents with a high level of education	333	38.2%
Health expenditures are out of respondent's own pocket	128	14.7%
Health perceived as below average or did not answer	78	8.9%
Health perceived as above average	446	51.1%
Relative or friend had kidney failure	455	52.2%
Respondents who have never been diagnosed with a chronic disease	588	67.4%
Respondents who have been diagnosed with COVID-19	151	17.3%
A close friend or family member was diagnosed with COVID-19	503	57.7%
Respondents who thought the risk reduction was permanent	70	8.0%
Respondents who considered other health issues (co-benefits)	83	9.5%
Respondents who strongly agreed they would pay almost anything to reduce risks	220	25.2%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	135	15.5%
Protesters: Did not answer as in real life, or did not have enough information	52	6.0%

United Kingdom

Table B.17. Summary statistics for continuous variables - United Kingdom

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	1 024	15.8	12.6	15.3	5.9	228.1
Time for 1st dichotomous choice question (seconds)	1 024	21.0	16	34.9	4	891
Time for 2nd dichotomous choice question if first response was No (Current risk)	308	15.2	7	117.3	2	2060
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	717	9.1	7	10.0	2	225
Total time to complete both valuation questions (seconds)	1 024	32.0	24	74.0	12	2088
Cost over 5 years for 1st dichotomous choice question (in USD)	1 024	1 699	1 201	1 421	267	4 805
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	1 024	1 478	1 068	1 721	133	9 611
Baseline Risk	1 024	30.9	25	17.9	15	60
Monthly household income (in USD)	887	3 792	3 338	2 502	601	10 213
Monthly household income (w/ predicted, in USD)	1 024	3 700	3 315	2 384	601	10 213

Table B.18. Summary statistics for indicator variables – United Kingdom

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	99	9.7%
Age 27-34	153	14.9%
Age 35-39	84	8.2%
Age 40-44	108	10.5%
Age 45-59	310	30.3%
Age 60-65	101	9.9%
Age 65+	169	16.5%
Female	555	54.2%
Respondents who said Yes-Yes to pay for risk reductions	190	18.6%
Respondents who said No-No to pay for risk reductions	490	47.9%
Respondents who said Yes-No to pay for risk reductions	118	11.5%
Respondents who said No-Yes to pay for risk reductions	226	22.1%
Respondents with a high level of education	507	49.5%
Health expenditures are out of respondent's own pocket	66	6.4%
Health perceived as below average or did not answer	158	15.4%
Health perceived as above average	402	39.3%
Relative or friend had kidney failure	262	25.6%
Respondents who have never been diagnosed with a chronic disease	726	70.9%
Respondents who have been diagnosed with COVID-19	112	10.9%
A close friend or family member was diagnosed with COVID-19	440	43.0%
Respondents who thought the risk reduction was permanent	34	3.3%
Respondents who considered other health issues (co-benefits)	99	9.7%
Respondents who strongly agreed they would pay almost anything to reduce risks	66	6.4%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	40	3.9%
Protesters: Did not answer as in real life, or did not have enough information	24	2.3%

United States

Table B.19. Summary statistics for continuous variables – United States

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total time to complete the entire survey (minutes)	959	19.6	13.6	21.5	6.3	282.8
Time for 1st dichotomous choice question (seconds)	959	31.0	16	122.8	3	2414
Time for 2nd dichotomous choice question if first response was No (Current risk)	331	10.9	8	15.0	2	178
Time for 2nd dichotomous choice question if first response was Yes (Lower risk)	629	10.0	7	9.9	2	94
Total time to complete both valuation questions (seconds)	959	41.3	25	124.7	12	2434
Cost over 5 years for 1st dichotomous choice question (in USD)	959	1 647	1 200	1 354	300	4 900
Cost over 5 years for 2nd dichotomous choice question (½ or 2 times 1st cost)	959	1 535	1 200	1 810	150	9 800
Baseline Risk	959	30.5	25	17.8	15	60
Monthly household income (in USD)	878	5 909	3 751	5 138	750	17 552
Monthly household income (w/ predicted, in USD)	959	5 733	3 751	4 969	750	17 552

Table B.20. Summary statistics for indicator variables - United States

Variable	Obs, Variable=1	Percent of total obs.
Age 18-26	103	10.7%
Age 27-34	123	12.8%
Age 35-39	108	11.3%
Age 40-44	106	11.1%
Age 45-59	274	28.6%
Age 60-65	245	25.5%
Age 65+	0	0.0%
Female	583	60.8%
Respondents who said Yes-Yes to pay for risk reductions	212	22.1%
Respondents who said No-No to pay for risk reductions	443	46.2%
Respondents who said Yes-No to pay for risk reductions	119	12.4%
Respondents who said No-Yes to pay for risk reductions	185	19.3%
Respondents with a high level of education	416	43.4%
Health expenditures are out of respondent's own pocket	132	13.8%
Health perceived as below average or did not answer	137	14.3%
Health perceived as above average	398	41.5%
Relative or friend had kidney failure	312	32.5%
Respondents who have never been diagnosed with a chronic disease	664	69.2%
Respondents who have been diagnosed with COVID-19	111	11.6%
A close friend or family member was diagnosed with COVID-19	476	49.6%
Respondents who thought the risk reduction was permanent	49	5.1%
Respondents who considered other health issues (co-benefits)	88	9.2%
Respondents who strongly agreed they would pay almost anything to reduce risks	96	10.0%
Yea Sayers: Answered Yes-Yes and strongly agreed to pay almost anything	56	5.8%
Protesters: Did not answer as in real life, or did not have enough information	22	2.3%

Valuing a reduction in the risk of chronic kidney disease

Compromised kidney function is associated with an array of environmental contaminants and chemicals, including heavy metals, certain organic solvents, and polycyclic aromatic hydrocarbons (PAHs), as well as food and waterborne pathogens. Many of these hazards are subject to regulation, or may be considered for regulation, in order to reduce exposures and prevent human health risks. However, valuation estimates for kidney effects that can be used in cost-benefit analyses are few, particularly willingness-to-pay estimates. In particular, there appears to be no willingness-to-pay (WTP) estimate available for reduced risk of chronic kidney disease and therefore no estimate for the Value of a Statistical Case (VSC) of chronic kidney disease.

This paper is part of the series of large scale WTP studies resulting from the Surveys to elicit Willingness to pay to Avoid Chemicals related negative Health Effects (SWACHE) project that intends to improve the basis for doing cost benefit analyses of chemicals management options and environmental policies in general. The present paper details a stated preference survey estimating WTP to reduce the risk of symptomatic chronic kidney disease, termed serious kidney disease in the survey instrument, filling an important gap in the valuation literature and addressing a need for applied benefits analysis for chemicals regulation. The SWACHE chronic kidney disease survey was fielded in ten countries: Canada, Chile, China, Denmark, Germany, Italy, Norway, Türkiye, the United Kingdom and the United States. In each country, a sample of 1 200 respondents representative of the general population was collected and empirically analysed.

Based on this survey, the mean (median) WTP for an average reduction of 3.5 in 1 000 in the risk of chronic kidney disease over five years is equal to USD_{2022} Purchasing Power Parity (PPP) 2 609 (764) per year, corresponding to a mean (median) VSC of chronic kidney disease equal to USD_{2022} PPP 805 000 (224 000). The mean VSC varies between USD_{2022} PPP 700 000 for Canada and USD_{2022} PPP 1 200 000 for Türkiye.

Recommended citation: Dockins, C., D. Dussaux, C. Griffiths, N. Simon and S. Hoffmann (2023), *"Valuing a reduction in the risk of chronic kidney disease: A large scale multi-country stated preference approach"*, OECD Environment Working Papers, No. 216, OECD Publishing, Paris, https://doi.org/10.1787/9c93138f-en.

The OECD SWACHE project has received the financial assistance of the European Union. The views expressed herein can in no way be taken to reflect the official opinion of the European Union.

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