Comparing mortality risk reduction, life expectancy gains, and probability of achieving the full life span, as alternatives for presenting CVD mortality risk reduction: A discrete choice study of framing risk and health behaviour change

Abstract

The growing rate of obesity has recently required governments to divert considerable resources in the promotion of healthy lifestyles. We explored the relative effectiveness in inducing healthy behaviour change of three different communication strategies about the benefits of an intervention that reduces the mortality risks of cardiovascular disease (CVD) and encourages respondents to embrace healthier lifestyles. We designed a Discrete Choice Experiments questionnaire to analyse the trade-off between lifestyles, defined in terms of diet and exercise, and reduction in cardiovascular disease (CVD) mortality risk. We set three ways of framing an identical benefit: (A) as a reduction in mortality risk from cardiovascular disease, (B) as an increase in months of life expectancy, and (C) as an increase in the probability of reaching an individual's full lifespan. The experiment was tailored for each subject in the sample according to his/her individual's baseline information on diet and physical activity. During the period February 2010 - July 2011, we interviewed 1,008 individuals in Northern Ireland, split randomly into three samples for the three CVD risk reduction frames. Considering the models' goodness of fit and significance, we conclude that the most effective way of communicating these CVD health benefits is using an increase in life expectancy, since with this frame individuals are more inclined to state that they would change to a healthier lifestyle.

Keywords: Northern Ireland (UK), Framing CVD mortality risk reduction, Health behaviour change, Value of statistical life, Value of a life year, Life expectancy, Stated preferences, discrete choice experiments.

1. Introduction

Obesity has become a growing problem affecting most Western societies. According to the World Health Organization (WHO), in 2008 there were about 1.5 billion overweight adults. This figure is increasing due to sedentary lifestyles and worsening eating habits (WHO, 2011). In Northern Ireland, almost 70% of adults are either overweight or obese and, according to the Public Health Agency, the number is growing. This epidemic has become an economic burden (Müller-Riemenschneider, 2007), as well as a major health problem, as obesity increases the risk of type 2 diabetes, cancer and cardiovascular diseases (CVD). As a result, governments and public health agencies are diverting considerable resources to prevent obesity and promote healthy lifestyles (WHO, 2001; Fit Futures, 2006; Foresight Report, 2007; DHSSPS, 2010).

The effectiveness of these policies has been rarely assessed because an ex-post assessment requires certain conditions that are difficult to achieve (Capacci et al. 2012). Using Stated Preferences (SP) previous studies have done ex-ante analysis and estimate the monetary benefits of programmes aimed at reducing the mortality risk of cardiovascular disease (Tolley et al, 1994, Cameron et al, 2008, Chestnut et al, 2012, Olofsson et al, 2016).

In this paper, we explore the relative effectiveness in inducing healthy behaviour change of three different communication strategies about the benefits of an intervention that reduces the mortality risks of cardiovascular disease (CVD) and encourages respondents to embrace healthier lifestyles. We compare three methods for presenting identical health outcomes: as a CVD mortality risk reduction (Outcome Frame A), as an increase in life expectancy (Outcome Frame B), as an increase in the probability of reaching an individual’s full lifespan (Outcome Frame C). These three approaches also allow us to estimate and compare the willingness to pay (WTP) for mortality risk reduction expressed in terms of the value of a statistical life (VSL) (Jones-Lee, 1974; Viscusi, 1993; Viscusi and Aldy, 2003; Jenkins et al, 2001; Blomquist, 2004; Gayer et al., 2000, 2002; Alberini and Ščasný, 2011; Krupnick et al, 2002; Tsuge et al, 2005) and the value of a life year lost (VOLY) (Chilton et al, 2002, Desaigues et al, 2007). This will allow us to suggest policy recommendations use the most effective framework to induce this type of health behaviour change.

The literature distinguishes between two types of interventions: those that aim for the early detection of disease and those that aim to change behaviours that contribute to the risk of disease. An early detection intervention attempts to convince people of the benefits of screening (i.e. breast examination for cancer) in order to mitigate and improve the outcomes of certain conditions. A behaviour change intervention tries to persuade individuals to adopt a healthier lifestyle to obtain a specific health outcome, for example, by attempting to persuade people to change their diet, alcohol consumption, or smoking habits. A loss framing message in health interventions expresses what would be the likely outcome in the event that the individual does not act in a certain way (i.e. lack of adequate exercise increases the likelihood of suffering from CVD), whereas a positive framing highlights the benefits of acting in a certain way (doing exercise reduces the chances of suffering from CVD). Framing in terms of loss or gain has an impact on an individual’s choices (Rothman et al. 2006; Rothman & Salovey, 1997). The consensus is that, for early detection behaviour, a loss-framing message is more impactful (see, for instance, Edwards et al 2001), which is consistent with Kahneman and Tversky’s (2013) prospect theory. By contrast, a gain-framing message is more appealing for behaviour change. There is natural variability in results depending on the intervention and health status of the individual. For instance, Van Assema et al. (2001) find mixed results in nutrition interventions, whereas Latimer et al (2008) confirm the greater effectiveness of gain framing messages for physical activity. Regarding the type of individual, if people are already involved with a particular health issue, a loss-framing message might be more impactful (Tanner et al 2008). Our analysis proposes a gain-framing message: individuals are informed that if they follow certain lifestyles, their health will improve. However, the literature has seldom explored the way that this outcome is expressed within a particular gain-framing strategy. Kelly and Rothman (2001), mentioned in Rothman et al (2006), compared a health problem versus a health benefit: "when people were encouraged to test for a health problem, a loss framed pamphlet was more effective […] but when people were encouraged to test for a health benefit, a gain framed pamphlet was more effective" (Rothman et al 2006, p S210). Following Kelly and Rothman (2001), we test whether a gain-frame presentation of health benefits (outcome Frame B and C) is more valuable than a gain-frame presentation of reduced health risks (outcome frame A).

Several monetary valuation studies have used the concepts of mortality risk reduction (see for example Krupnick et al, 2002; Alberini et al, 2004; Alberini and Ščasný, 2011), or life expectancy gains (Chilton et al, 2002, Desaigues et al, 2007). The concept of achieving an individual's full life span has been frequently used in policymaking (Andersen, 2017), however no Stated Preference WTP study has compared the three frames.

Following Kelly and Rothman (2001), we test whether a gain-frame presentation of health benefits is more valuable than a gain-frame presentation of reduced health risks with the following ex-ante hypotheses:

H1) WTP for VOLY delivered by Outcome Frame A < WTP for VOLY delivered by Outcome Frame B or C

In addition, as many benefits in public health have traditionally been communicated as additional life years, and as this concept is easily grasped by the general public we seek to test the hypothesis that WTP for VOLY delivered by Outcome Frame B is larger than WTP for VOLY delivered though Outcome Frames A or Frame C:

H2) WTP for VOLY delivered by Outcome Frame A and Frame C < WTP for VOLY delivered by Outcome Frame B.

If hypothesis H2 is not rejected, than Outcome Frame B should be recommended for policy communication when the goal is to obtain participants' commitments towards a behaviour change and to embrace healthier lifestyles in the context of CVD risks .

With this purpose, we analyse a complex intervention that combines diet and physical activity with its subsequent health effects within a Discrete Choice Model-Stated Preference framework. The departure point is the individual's status quo in terms of diet, exercise and cardiovascular risk. This lifestyle is set after we obtain information from a detailed individually tailored questionnaire as outlined in Grisolía et al (2013, 2015).

We find that the most effective way of communicating health benefits in this case is using an increase in life expectancy, Outcome Frame B. Our estimates for VSL and VOLY are within the ranges of values obtained in the literature, which lends credence to our risk communication and behaviour change study.

Section 2 describes the concepts of VSL and VOLY. Section 3 presents the questionnaire, the Outcome Frames A, B, and C, the experimental design and the data collection. Section 4 presents the econometric models. Sections 5 and 6 report the results and discussions respectively, and section 7 concludes the paper.

2. VSL vs VOLY

2.1. The value of statistical life (VSL)

The VSL can be defined as the marginal rate of substitution between wealth and mortality risks for the entire population (Jones-Lee, 1974; Viscusi, 1993). This trade-off can be studied by observing people's actual choices of jobs or goods - revealed preferences (RP) - or by examining individual's choices in stated preference (SP) surveys. In the first case economists analyse wage-risk in the labour market for dangerous occupations (Mrozek and Taylor, 2002; Viscusi and Aldy, 2003) or averting cost expenditures (see, for instance Blomquist, 2004). Some observers point out that RP methods could be inappropriate because they might not reflect the general population's behaviour, but only the behaviour of certain types of individuals (e.g. industrial workers) (OECD, 2011; Baker et al, 2008). For this reason, it has become popular to use SP studies. Although some countries, in particular the US, still rely on RP methods, the EU regulatory practice is based on SP research, and Canada and Australia are increasingly moving towards SP for VSL calculations. SP methods, however, can have high cognitive requirements and are subject to several potential biases. In addition, the situations are hypothetical by definition.

Government agencies have undertaken exhaustive analyses of VSL estimates. The overall mean of a selected number of high quality SP studies in OECD countries shows, VSL estimates ranges from USD 1.45 to 4.35 million (2005-USD), with an average of USD 2.9 million (Lindhjem et al., 2010, 2011). For the EU, the recommended range is USD 1.75-5.25 million (2005), with a mean of 3.5 USD million. For the US, the review made by Robinson and Hammitt (2015) provides a range for VSL between 1 to 10 million USD with a central estimate of USD 7.5 million. For Canada, the recommended value is around CAD 5.0 million with a range of 3.4 to 6.3 CAD million (Chestnut and De Civita, 2009), and for Australia the VSL is set around AUD 3.5 million. The UK department of transport, which has made calculations since 1993, recommends 1,080,760 GBP as a midpoint of a range of 750.000-1.250.000 GBP (OCDE, 2011).

2.2. The value of a life year

The value of a life year (VOLY) or Quality Adjusted Life Year (QALY) can be calculated from SP surveys as well, obtained from cost-effectiveness analyses and inferred from VSL estimates (Ryen and Svensson, 2015). VOLY can be calculated from VSL estimates assuming a mean value for life expectancy and a discount rate (Abelson, 2003). For instance, a VSL of 1,000,000 GBP, considering a discount rate of 5% and 40 years of life, would lead to a VOLY of GBP 55,068 (assuming perfect health status, as done by Abelson, 2003). The main difference between QALY and VOLY is that the latter does not necessarily take into account the quality of a life year gained.

In contrast to the vast literature on VSL, there have been relatively few studies on VOLY. Nevertheless, Desaigues et al (2011) argue that VOLY might be a more realistic value than VSL because air pollution - the usual case for SP studies on VSL - cannot be considered as the primary cause of individual death but a factor shortening life. In terms of policy applications, the UK is one of the few countries that uses VOLY, using a value of GBP 29,000 for the VOLY in normal health (Chilton et al., 2002). The European Commission recommends a range for VOLY of €50.000-100.000 (European Commission 2009, Annexes p 43), while Ryen and Svensson (2015) made an extensive review of the QALY literature, which offers 383 estimates with a mean of €74,159.

3. Questionnaire

3.1. Survey development and administration

The three ways to communicate an identical health benefit that we considered were: a reduced risk of suffering a fatal cardiovascular incident (Outcome Frame A), an exactly equivalent extension in months of life expectancy (Outcome Frame B) and an exactly equivalent increase in the probability of reaching the individual's full lifespan (Outcome Frame C).

Nielsen et al. (2010) and Hammitt and Tunçel (2015) have shown that respondents have preferences in valuation of mortality risk reduction between different timing profiles or risk reductions which all provide identical life expectancy gains. Unlike Nielsen et al. (2010), we study alternative risk communication or risk framing methods for presenting the same risk reduction, rather than alternative and different temporal profiles of risk reductions. Figure 1 shows a flow chart of our survey design and questionnaire versions. Ethical approval for this study was obtained from the Ethical Research Committee of the School of Biological Sciences, Queen's University Belfast.

Figure 1 about here

Table 1 describes the number of questions and the type of questions for every part of the survey. The questionnaire had 70 questions divided into eight sections: health, physical activity, diet, choice, follow-up, locus of control and sociodemographic characteristics. We began with 19 general questions about health adapted from the MOS SF36 health questionnaire (Mc Horney et al 1994). The subject's personal data was then incorporated in the QRISK1 prediction algorithm (Hippisley-Cox et al., 2007) to estimate the respondent's own CVD mortality risk over the next 10 years (see Grisolía et al 2013; Grisolía et al 2015 and Boeri et al 2013). We included a personal physical activity questionnaire of five questions based on the UK National Health Service version of the International Physical Activity Questionnaire (IPAQ) (Craig et al, 2003) to elicit the respondent's engagement with moderate physical activities (household work, gardening, shopping), moderate exercise (walking, cycling) and vigorous physical activities.

Table 1 about here

Having initially determined the health status quo and physical activity habits of the respondent, the questionnaire also explored a respondent's eating habits to later design the individually tailored SP exercise. As we deemed it impractical for a CAPI interview to use a diary of food intake during one week (Alliance, I. U. N., 2001), we focused on eliciting the respondent's consumption of food items with a high fat content, as these items could lead to high levels of blood cholesterol and, therefore, are likely to contribute to CVD. We adapted to the Irish diet the Block Questionnaire (Block, 2000). This is a tool developed in the nutritional literature that offers a snapshot of an individual's level of fat intake through questions about the eating frequency and the portion size for 19 selected items (Joyce et al, 2007). Respondents were asked the frequency of consumption of these items from 'never' to 'five or more times a week.' Each item was presented on a separate screen. After the frequency, individuals were asked about portion sizes and cooking styles. We would later use the answer to the Block Questionnaire to build the 'diet' attribute for the choice experiments (CE) questions, as described below.

From this point, the questionnaire was split into two parts: the risk questionnaire and the lifespan questionnaire (Outcome Frames A and C) contained a tutorial about probability. This risk tutorial explains the idea of probability using visual aids (Alberini et al., 2004). For Outcome Frame B (Life Expectancy Gains) although the tutorial on probability was not necessary, as this version did not engage the respondent with a probability exercise, a section of equivalent length was included on individual life expectancy tables. Each experiment continues with 10 CE questions, followed by three questions about whether the subject had paid attention to the attributes in the experiment. Finally, there were 13 socio-economic questions.

To finalize the survey questions and improve its wording, we completed five focus group with 12 participants in each group recruited through community centres in Northern Ireland. Each participant was paid 25 GBP for their participation. Three focus groups took place in Belfast - two in Queen's University Belfast premises and one in a community centre ina deprived area of the city. One focus group took place in Holywood, a wealthy town, and another focus group was organized in Derry/Londonderry, where participants came from lower socio-economic groups. Participants were at least 40 years old with a roughly equal split between female and male in each focus group. The focus group template contained 10 questions including rating factors affecting food choices, relationship between lifestyles and health risks and a rating exercise about factors preventing risks of a heart attack. During the session we tested the tutorial on probability and risk and asked a contingent valuation question on the WTP to reduce the risk of a heart attack. This latter question was used to provide priors for our CE pilots. The sessions also revealed that most people are aware of the connection between lifestyle and CVD risks.

After completing the focus groups, the survey was administered by a marketing research firm in Northern Ireland to 1,008 randomly selected individuals interviewed in their homes from February 2010 to July 2011. We selected representative segments of different socioeconomic groups using multi-stage random sampling. To maximize response rate, the survey company we hired for the data collection aimed to achieve a 70% response rate requiring interviewers to make at least 5 calls to each address at varying times of the day and evening, with at least one call back been made at the weekend before an address was recorded as a non-contact.

3.2. Outcome Frame A: CVD Mortality Risk Reduction Framing

Individual's current CVD mortality risk was given as the status quo and health benefits were presented in terms of mortality risk reduction expressed in percentages. Although health risk is a negative concept, the outcome was positively framed – as a reduction of an individual's CVD mortality risk in the next 10 years. An example of an Outcome Frame A choice card is shown in Figure 2.

Figure 2: Example of a Outcome Frame A choice card

About here

3.3. *Outcome Frame B: Increase in Life Expectancy Framing*

In Outcome Frame B, the individual was informed about their likely life expectancy considering their age and gender. This information was obtained from the Interim Life Table published by the Government Actuary's Department in the United Kingdom. A respondent's "status quo" health was presented in terms of this life expectancy. Should the subject modify their diet and exercise habits, there would be an identical benefit in mortality risk reduction to that in Outcome Frame A but this was converted into increased months of life expectancy.

The Interim Life Table uses the following parameters to calculate life expectancy:

- x denotes year
- q_x is the mortality rate between age x and x+1

- l_x indicates the number of survivors of age x over a cohort of 100,000 births
- d_x is the number of individuals dying between year *x* and *x+1*. This can be obtained with the product of survivals and mortality rate; that is $d_x = q_x * l_x$
- m_x central mortality rate. For a particular cohort of year *x*, the mortality rate for a period of three years (considering the average population of this subgroup over the defined period)
- L_x is the number of years alive at each age *x* obtained taking the average of two years $\boldsymbol{L_x = \frac{l_x + l_{x+1}}{2}}$
- T_x is the sum of L_x for age *x* to the oldest age, it will gives the number of years lived from age c
- e_x represents life expectancy at age *x which is obtained as the ratio* T_x/L_x

For each cohort and gender, the Interim Life Table provides an average mortality rate q_x. This ratio would be increased by the CVD mortality risk that was estimated for each individual, altering their life expectancy to e_{qx} (denoting *q* the individual). This was the status quo condition. As our experiment offered a reduction in individual's CVD risk, for every alternative, d_{qx} is recalculated according to the experimental design. Altering d_{qx} brings a longer expectancy and it is possible to estimate the difference from the initial e_{qx}. These differences were transformed into months. Using a purpose specific Visual Basic program, the life expectancy for each respondent was calculated *ad hoc* during the interview using the respondent's data. Table 2 provides an example of the health benefits part in an Outcome Frame B choice card. Details of this algorithm are presented in the Appendix 1.

Table 2 about here

3.4. Outcome Frame C: Increased Probability of reaching your full life span Framing

The probability of reaching the full life span expresses the probability that the individual would achieve the totality of their anticipated life expectancy at birth. This information was retrieved from the survivorship rate l_x in the Interim Life Table. This parameter represents the proportion of individuals of a particular age cohort that survive to a certain age. This was used as the baseline for the probability of reaching an individual's life span. Increases in this probability which were exactly equivalent to the reduction of CVD mortality risk in Outcome Frame A were estimated *ad hoc* in the same manner as we did in Outcome Frame B. Since increases were small, they were shown in figures per thousand, as well as in percentage terms (see Table 3). Before displaying the choice scenarios, respondents were trained about the concept of life span and survival rates. Figure 3, taken from Nielsen et al (2010), shows a visual aid used for this purpose.

Figure 3: Survival Rates by Age Cohort: Taken from Nielsen et al (2010)

About here

Table 3 about here

Table 4 reports the current initial mortality risk of 5% for a 50 years old male respondent, calculated with the QRISK1 algorithm (Hippisley-Cox, 2007), and the alternative hypothetical reduced risks for Choice A and Choice B in the 10 Choice Occasions presented to this respondent by our experimental design. The table then presents the corresponding current life expectancy gains and the current and improved probabilities for reaching the full life span.

Table 4 about here

3.5. Experimental design

Our choice experiments questions entailed four attributes: diet, physical activity, CVD mortality risk – as defined by Outcome Frames A, B or C – and a cost to the respondent. Physical activity was defined as minutes spent in moderate forms of physical exercise per day. The levels of this attribute were: the current level of physical activity, and increases by 10, 20, 30, or 40 minutes per day compared to the current level. The CVD mortality risk was defined as the probability of a fatal heart attack in the next ten years. The level for the current life style was the one resulting from the QRISK1 prediction algorithm. The levels for the alternative scenarios were calculated as a reduction in such a risk by 40%, 50%, 60%, 75% and 85%. Therefore, for a respondent whose current risk was equal to 5%, a 50% reduction would result in a risk of 2.5%. Reductions in risk were transformed for Outcome Frames B and C using the procedure described above. We were therefore able to communicate identical CVD mortality risk reductions using three different Frames or methods of risk communication. The cost for achieving these benefits was described as an increase in the money spent on food and physical exercise per week. Levels were 0, 2, 5, 7, 10, 15 and 18 GBP. The diet attribute was built from the adapted Block Questionnaire where we selected, for each respondent, the five (unhealthy) food items most frequently consumed by that individual. This information was presented to respondents as their current choice. The alternative hypothetical scenarios were described in terms of reductions in the consumption of these five items and an increase in fruit and vegetables. We selected four levels for the diet attribute defined in terms of overall fat content. Considering the current diet as the reference value, we defined "light", "medium", "high" and "restricted" diets, corresponding to reductions in fat intake by 10% (light), between 20% and 30% (medium), between 40% and 50% (high) and between 60% and 75% (restricted) from the current diet respectively. This approach allowed us to compare diets across respondents and build a variable expressed in terms of reduction of grams of fat from the current diet. Table 5 shows the attributes and their levels used in this CE.

Table 5 about here

Once the attributes and levels were decided, we inserted 10 choice sets, with each choice set described by three options, a respondent's current lifestyle and two hypothetical lifestyle alternatives. To determine the choice sets and the combination of attribute levels for each alternative, we used a Bayesian D-efficient experimental design (Bliemer et al., 2009; Scarpa, Campbell and Hutchinson, 2007; Ferrini & Scarpa, 2007). This design consists of a combination of attributes and levels that maximizes the information obtained from respondents. In practical terms, this means a design that yields the smallest standard error (Rose et al., 2008). For the initial experimental design, we set our priors to zero (Kessels et al 2006). In the following designs, we inserted as priors the estimates from a multinomial logit model obtained using the data from the pilot surveys. All designs were implemented in VBA in Excel following the recommendations by Rose et al (2008).

Every survey was pre-tested twice – except Outcome Frame C, which was tested only once due to budget constrains – with pilot questionnaires administered to a sample of 90 individuals. This helped us improving wording, show cards photos, position of questions, and rephrasing to simplify the questionnaire.

Table 6 about here

4. Econometric Models

Choice Experiments are based on the Random Utility Theory (Train, 2011) which considers that an individual's choices produce certain utility *U* which contains a part *V* that can be measured in terms of the attributes of each alternative (Lancaster, 1966), and another part ε that cannot be observed and therefore is considered a random term. When facing a set of *J* alternatives, individuals will select the one providing the highest utility. As shown in (1), the utility associated with option *j* can be decomposed into *V*, the modelled component and ε, the error component. The first term can be expressed as the sum of the product of *k* attributes *x* multiplied by their weights β_k.

$$U_j = V_j + \varepsilon_j = \beta_{0j} + \beta_{1j}x_1 + \beta_{2j}x_2 + ... + \beta_{kj}x_k + \varepsilon_j \quad (1)$$

A Random Parameter Logit (RPL) model allows for differences in tastes by assuming that β are not fixed but vary across respondents (Train, 1998). We apply a classical estimation with 1,000 draws and assuming a Normal distribution for random parameters in the RPL. Correlation amongst attributes was assumed absent and therefore the covariance matrix for the RPL model estimation was diagonal. In addition, we estimated a Willingness to Pay Space (WTP) model (Train and Weeks, 2005). To test hypothesis H1 and H2 we compare the WTP estimates from Outcome Frames A, B and C for the CVD risk reduction attribute, everything else being equal. We run two models for each Outcome Frame: a Random parameter logit (RPL) model, displayed in Table 7 and a Willingness To Pay Space (WTP) model shown in Table 8. All models were estimated using Biogeme (Bierlaire, 2003). From the WTP for reducing by 1% fatal CVD risk we obtained the VSL converting this payment in a 10-year weekly payment and dividing it by 1%, considering the actual average risk in the sample. To calculate the VOLY from Outcome Frame B, we took the WTP for a one-month life extension and multiplied it by the number of weeks in one year, 52, and further multiplied it by 10 for a 10-year life expectancy gain.

The econometric models use the independent variables *Fat*, *Exercise*, *Cost*, *Risk*, *LE (Life Expectancy) and Lifespan*. *Fat* represents the sacrifice of a respondent's current diet in terms of grams of fat per week that the individual is asked to give up in the hypothetical scenarios. This variable was created using the information from the adapted Block Questionnaire and translated into grams of fat using the study of calories and fat provided by McCance and Widdowson (2002). *Exercise* represents the contribution to utility of one additional minute of moderate exercise. *Cost* is the payment for changes in lifestyle, justified in terms of increasing costs of healthy diets and exercise, measured in GBP per week. *Risk* is the risk of suffering a fatal CVD event over the next ten years, expressed on a percentage basis. *LE* represents extra months of life, *Lifespan* represents the increasing probability of reaching the average lifespan.

5. Results

Table 7 about here

5.1. Random Parameter Logit

Before running our econometric models, we compared the three subsamples using the Kruskal-Wallis test for selected socio-demographic variables. Table 6 displays these results. We cannot reject the null hypotheses of no differences across the three Outcome Frames samples at the 5% significance level for all variables except for unemployed and degree holder. The sample that received Outcome Frame A comprises more unemployed respondents than the other two samples, whilst the group that received Outcome Frame B includes less highly educated respondents.

In the econometric models, we allowed all parameters to be random, including the alternative specific constant (ASC), except fat, since its spread (σ) was not statistically significant. Outcome Frame B, which presented the health outcome as life expectancy gains presents the highest log-likelihood (or lowest in absolute terms), and best AIC and BIC statistics, thus clearly outperforming the models for Outcome Frames A and C. The key attribute of interest in each model is the one that captures the CVD mortality risk reduction benefits. Surprisingly, Outcome Frame C reports a negative and statistically significant coefficient for the increase in probability of achieving a person's full life span, suggesting that people prefer a scenario with a lower probability of achieving their full life span.

To further explore the importance of CVD risk in people's choices, we look at the spread of the coefficient estimates σ for this attribute in the three models. Whilst we notice that Outcome Frames A and C have large relative values for σ compared to the size of the mean μ, Outcome Frame B has a relatively small value for σ, indicating that Outcome Frame B elicits more homogeneous preferences. Since the model employs a normal distribution for the spread of CVD risk, we can estimate the percentage of people exhibiting positive or negative preferences towards CVD risk reduction. For Outcome Frame B, about 93% of individuals exhibit positive preferences for CVD risk reduction, for Outcome Frame A. this percentage falls to about 70%, and for Outcome C it further drops to 39%. These results would indicate that gains in life expectancy are a better way to present a CVD health dividend to a large representative sample of the public.

The sign on the "status quo" parameter indicates whether individuals are satisfied with their current situation. All models show that the coefficients for the status quo are negative and significant, suggesting that individuals are discontent with the current situation. Interaction terms between socio-economic variables and the status quo are not statistically significant in Model A. In model B, highly educated people (degree holders) are less likely to choose the current situation, whilst respondents enjoying good health and male respondents are more likely to choose their current lifestyle. The interpretation of the results for model C is more problematic, as we find a counterintuitive sign for the interaction term between good health and the current situation.

It is interesting to analyse how these models affect stated behavioural change suggested in the experiment. Individuals seem content with the idea of dietary change in all models, except model C. As for exercise, the perception is positive particularly in Outcome Frame B, where about 90% of individuals see more exercise as something positive compared with 60% for Outcome Frame A. Summing up, in terms of desirable CVD relevant behavioural change forecasts, the most "persuasive" model seems to be Outcome Frame B.

5.2. Willingness-To-Pay Space models

Willingness-to-pay estimations were made using WTP space models, reported in Table 8. In terms of goodness of fit, the best WTP space model is B, with the lowest log-likelihood in absolute terms, and better AIC and BIC statistics. The coefficients for *Fat* and *exercise* are scaled and must be divided by 100 when interpreting their meaning. In addition, minutes of exercise were transformed into Metabolic Equivalent Task (MET), a measure for units of energy (see for instance Jette et al, 1990; Ainsworth et al., 1993). The results from Outcome Frame B show that about half of the respondents are willing to pay to increase their physical activity, with quite some variation in the sample, as captured by the standard deviation. Under Outcome Frame A, since mean WTP is negative, we see that most individuals should be compensated to increase their physical activity. In contrast, with Outcome Frame C, individuals show on average a positive WTP to increase their physical activity levels.

The mean WTP coefficient estimates for reducing fat from the diet are negative for all Outcome Frames, showing that, on average, people need to be compensated to reduce fat intake from their diets. Around 70.5% of the range of WTP is negative in Outcome Frame A, 80% in Outcome Frame B, and 100% in C. Thus, individuals seem to be less reluctant to follow a diet when they are being offered a longer life as a reward than a straightforward risk reduction or higher probability of achieving a full life span. Not surprisingly, exercise is still the most preferred intervention (Ryan et al 2015) for which respondents would require lower payments on average than for dieting.

Finally, the mean WTP for CVD risk reduction shows that people need to be compensated by about £1/week to have their fatal risk increased by 1% as shown by Outcome Frame A. Outcome Frame B shows that respondents are willing to pay about £10/week to extend their life expectancy by 1 month. Outcome Frame C reports a negative mean WTP for increasing the chance of achieving the full life span. When we look at the distribution of WTP for CVD risk reduction, we find that, under Outcome Frame A and B, about 93% and 85% of the sample respectively have a positive WTP for reducing their CVD risk, whilst with Outcome Frame C about only 44% have a positive WTP for increasing their probability of achieving their full life span. This latter result highlights that the majority of respondents presented with Outcome Frame C have a negative WTP for CVD risk reduction, a counterintuitive result.

When we further analysed the results excluding non-traders (respondents who always select the same alternative) or non-demanders (people who always choose their status quo) we did not find notable differences with our full sample models.

6. Discussion

From Outcome Frame A, for a 1% reduction in the risk of death from CVD (over the next ten years), we obtain a WTP of 511.68 GBP, which leads to a VSL estimate of 814,777 GBP. Using the WTP obtained from the Life Expectancy Model (Outcome Frame B) we estimate the VOLY as 63,024 GBP. The VSL from Outcome Frame A obtained here is 24% smaller than the central value recommended by the UK Department of Transport, although it is within the recommended range. Conversely, the VOLY (Outcome Frame B) calculated here is above the value applied in the UK but it is within the range recommended by the European Commission. It is interesting to observe that our VOLY of 63,024 GBP is almost exactly the same as that recommended by Ryen and Svensson (2015). Indeed, their estimate was €74,159 and the appropriate conversion into euros, for our estimate is €73,738 (using 2010 annual exchange rate). From the VSL obtained in Outcome Frame A we can infer, assuming 40 years of remaining life and a discount rate of 3%, a VOLY of 34,222 GBP. Similarly, using the VOLY from project B, and applying the same discount rate of 3%, we estimate a VSL equal to 1,500,488 GBP.

Model B, based on life expectancy, is not only able to generate a VOLY that accords with the current literature and provides the best goodness of fit; it also offers additional insights from the socioeconomic interactions. The enhanced life expectancy scenario, without the need to instruct respondents on the concept of probability, and by providing a positive health frame, has proved most effective in guiding respondents into choosing healthier lifestyles. Outcome Frame A generates reasonable results in behavioural terms that mirror Outcome Frame B, though, in the case of this exercise, Outcome Frame B shows a higher commitment from individuals since the positive range is larger. In terms of monetary values, its WTP for CVD risk reduction is greater than B.

The results obtained from Outcome Frame C show that the majority of respondents need to be compensated to choose a scenario with an increased probability of achieving their full life span. Whilst about 44% of the sample administered with Outcome Frame C has a positive WTP for CVD risk reduction, about 56% need to be compensated. Therefore, we do not recommend using these results for estimating VSL or VOLY. The results from Outcome Frame C also shows very high levels in terms of WTP for increasing physical activity levels and willingness to accept for reducing fat intake. To investigate these abnormal results, we carried out some one-on-one interviews to explore any weaknesses with Outcome Frame C. The feedback we obtained from these interviews are that people require much more training to properly understand the scenario of the probability of achieving the full life span. Under Outcome Frame C, people are told that, given their age, health and lifestyle, they have a certain (fairly high) probability of achieving their full life span. People are then told what this age is. They are then presented with hypothetical scenarios where the probability of achieving their full lifespan is increased (by very small amounts) This frame is rather different from Outcome Frame A or B, where the hypothetical scenarios are presented as either a mortality risk reduction (and therefore one can expect to live longer as a consequence of a reduction in mortality risk), or an increase in the number of years of life. Outcome Frame C does not present such an intuitive increase in life expectancy. Respondents are not told that they will live longer than a certain age, but that they will be more likely to achieve the age of their full life span. To improve the understanding of Outcome Frame C, the questionnaire would have to become much longer to accommodate for an improved training in the concept of survivorship and the probability of achieving the full life span. Such a modified questionnaire, necessarily, would not be comparable with the questionnaires for Outcome Frame A and B, making it impossible to compare the different Frames as this would introduce a questionnaire length bias. Many of the problems of using a survivorship approach to communicating a specific (in our case CVD) risk reduction can be appreciated by inspecting the exactly equivalent choices in the choice sets outlined in Table 4. In Frame A we can see that some of the Option A and Option B choices can substantially reduce the specific CVD mortality risk (from 5% to 2% over a 10 years period). By contrast Frame C looks at the effect of CVD risk reduction in the context of survivorship and reaching your fully lifespan. This places CVD risk reduction in the context of all mortality risk reduction where the percentage increases in reaching your full lifespan (from reduced CVD risk) in Table 4 look very small, mostly increases from 67% to 68.5% or less. Other papers which have used this survivorship approach such as Nielsen et al (2010) have used extensive experimental laboratory training of subjects but have still faced this problem. In investigating preference between different ways of generating a 6 month gain in life expectancy Nielsen et al (2010) state *"the reason why a six- month gain was chosen is because compared with the risk reductions (and implied life expectancy gains) in a typical VSL survey, even a six month gain in life expectancy is a substantial good (for someone of average age the risk reduction in a typical VSL survey would generate a gain in life expectancy of a few hours or at most days and certainly less than a month)"* In terms of our study CVD risk reduction is clearly a very substantial good with Table 4 showing Life expectancy gains of up to 13 months. Even in the case of a 13-month life expectancy gain the equivalent probability of reaching your full life span only increases from 67% to 68.5%. Another paper by Mahmud (2009) on valuing mortality risk reduction in developing countries shows that using a survivorship approach even when given prior information on age related objective mortality risk people on average subjectively underestimated their own survivorship at younger and overestimated it at older age cohorts. We conclude, therefore, that further research should be done to investigate the use of Outcome Frame C for policy making before arguing that this frame is suitable for research purposes in the field. By contrast, increased life expectancy in Frame B has worked well in our case because CVD mortality risk is higher than many other specific mortality risks investigated in this type of study and this transfers to substantial increased in life expectancy that respondents find easy to value.

7. Conclusions

This paper investigates how individuals state they would change their lifestyles in exchange for certain health benefits. Identical benefits were expressed as a reduction of fatal CVD mortality risk in the next 10 years (Outcome Frame A), as a corresponding life expectancy gain in months (Outcome Frame B) and as an increase in the probabilities of reaching the individual's estimated full life span (Outcome Frame C). Using our Outcome Frame A sample, we calculated the value of statistical life in the context of CVD mortality risk as 814,777 GBP. From the Outcome Frame B life expectancy frame, we estimate the value of one extra life year (VOLY) as 63,024 GBP.

In terms of our models' goodness of fit and the significance of the relevant parameters, Outcome Frame B, that presents CVD risk reduction in the form of life expectancy gain, appears to be the most persuasive in achieving stated behaviour change intentions.

We also find that Outcome Frame B provides a higher mean WTP for CVD risk reduction, compared to the mean WTP estimated from Outcome Frame A and B. These results confirm that we cannot reject our hypotheses H1 and H2: (1) a gain-frame presentation of health benefits is more valuable than a gain-frame presentation of reduced health risks; and (2) presenting CVD risk reduction in terms of additional life years leads to higher WTP values. This might be the consequence of having a positively framed outcome and a simple message which does not require risk literacy or an understanding of probability. The life expectancy gain approach (of Frame B) is also particularly suitable for this specific study because CVD mortality risk is much greater than many of the mortality risks in VSL studies (such as from air quality and transport safety). As a result, life expectancy gains of up to and over 12 months can result from CVD risk reduction. By contrast, the probability of reaching a full life span (Frame C) is the least persuasive, and we find that our sample may have had difficulties in grasping the meaning of this novel method of benefit framing.

Our results are consistent with the literature; in the sense that gain-framed messages are persuasive for behavioural change intentions. We also find that when a gain-framed message is described in terms of health benefits, people are more likely to state that they wish to engage with healthier lifestyles. Personal lifestyle change necessitates individual agency and self-efficacy and this seems to be the reason behind the success of gain framing (Gallagher and Updegraff, 2012). It seems that in our case the combination of gain framing and an outcome expressed in terms of health benefit intensifies the effectiveness of the message.

This work has some limitations. All SP studies might be affected by hypothetical bias. In our case the real behaviour would imply a profound modification of people's lifestyles over years which requires a long commitment. On the other hand, the sample might be representative solely of the Northern Ireland population and these results cannot be extrapolated beyond that region. Finally, although the health benefits were originally equivalent by design, there are slight differences in the questionnaire administration that might have affect the results. It is disappointing that the results from Outcome Frame C, in which we presented the probability of achieving the full lifespan, were inconclusive and this is an area where future research on framing might offer useful behavioural insights.

Appendix 1

More specifically the method follows these steps:

1) With the risk calculated per respondent we modify *qx* to *qx*' which is higher
2) Recalculation *lx* considering the new *qx'*
3) A new estimation of the new *dx*' with the new *qx*'
4) Calculation of *Lx*'
5) From the age *x* sum of *Lx* will provide the total number of years lived (*Tx*') from age *x*.
6) The new life expectancy *ex* is calculated in each individual case.

This is done, for every individual once to set the baseline of life expectancy based on his/her risk and, for every alternative in every choice set. Since there is always a reduction of risk, this reduction will imply an increase in life expectancy. The difference, in months is translated into additions in life expectancy in Outcome Frame B.

REFERENCES

Abelson, P. (2003). The value of life and health for public policy. *Economic Record*, *79*(SpecialIssue).

Ainsworth B. E., Haskell, W. L., Leon, A. S., Jacobs, D. R., Montoye, H. J., Sallis, S. F., & Pafembarger, R. S. (1993). Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc*. 1993 Jan;25(1):71-80.

Alberini, A., & Ščasný, M. (2011). Context and the VSL: Evidence from a stated preference study in Italy and the Czech Republic. Environmental and resource economics, 49(4), 511-538.

Alberini, A., Cropper, M., Krupnick, A., & Simon, N. (2004). Does the value of a statistical life vary with age and health status? Evidence from the U.S. and Canada. *Journal of Environmental Economics and Management*, 48(1): 769–792.

Alberini, A., Hunt, A., & Markandya, A. (2006). Willingness to pay to reduce mortality risks: evidence from a three-country contingent valuation study. *Environmental and Resource Economics*, 33(2), 251-264.

Alliance, I. U. N. (2001). *North/South Ireland food consumption survey* (pp. 1027-1127). Irish Universities Nutrition Alliance.

Andersen, M.S. 2017. Co-benefits of climate mitigation: counting statistical lives or life-years?. Ecological Indicators, 79, 11-18.

Andersen, M.S. 2017. Co-benefits of climate mitigation: counting statistical lives or life-years?. *Ecological Indicators*, 79, 11-18.

Baker, R., Chilton, S., Jones-Lee, M., & Metcalf, H. (2008). Valuing lives equally: Defensible premise or unwarranted compromise? *Journal of Risk and Uncertainty*, *36*(2), 125-138.

benefits associated with reductions in air pollution: Final Report. DEFRA.
Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., ... & Oja, P. (2003). and the IPAQ Consensus Group and the IPAQ Reliability and Validity Study Group. International Physical Activity Questionnaire (IPAQ): 12-country reliability and validity. *Med Sci Sports Exerc*, *35*(13), 81-95.

Bierlaire, M., (2003). BIOGEME: A free package for the estimation of discrete choice models. *Proceedings of the 3rd Swiss Transportation Research Conference*, Ascona, Switzerland.

Bliemer, M. C. J., & Rose, J. M. (2008). Construction of experimental designs for mixed logit models allowing for correlation across choice observations. *87th Annual TRB Meeting*, Washington, D.C., January 2008, USA.

Bliemer, M. C., Rose, J. M., & Hensher, D. A. (2009). Efficient stated choice experiments for estimating nested logit models. *Transportation Research Part B: Methodological*, 43(1), 19-35.

Block, G., Gillespie, C., Rosenbaum, E. H., & Jenson, C. (2000). A rapid food screener to assess fat and fruit and vegetable intake. *American Journal of Preventive Medicine*, 18(4), 284e288.

Blomquist, G. C. (2004). Self-protection and averting behavior, values of statistical lives, and benefit cost analysis of environmental policy. *Review of Economics of the Household*, *2*(1), 89-110.

Blomquist, G. C. (2004). Self-protection and averting behavior, values of statistical lives, and benefit cost analysis of environmental policy. *Review of Economics of the Household*, 2(1), 89-110.

Boeri, M., Longo, A., Grisolía, J. M., Hutchinson, W. G., & Kee, F. (2013). The role of regret minimisation in lifestyle choices affecting the risk of coronary heart disease. *Journal of health economics*, 32(1), 253-260.

Cameron, T. A., DeShazo, J. R., & Johnson, E. H. (2008). *Willingness to pay for health risk reductions: Differences by type of illness.* Department of Economics, University of Oregon.

Capacci, S., Mazzocchi, M., Shankar, B., Macias, J. B., Verbeke, W., Pérez-Cueto, F. J., ... & Saba, A. (2012). Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition reviews*, 70(3), 188-200.

Chestnut, L. G., & De Civita, P. (2009). *Economic valuation of mortality risk reduction: Review and recommendations for policy and regulatory analysis*. Policy Research Initiative.

Chilton, S., Covey, J., Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N., & Spencer, A. (2002). Public perceptions of risk and preference-based values of safety. Journal of Risk and Uncertainty, 25(3), 211-232.

Chilton, S., Covey, J., Jones-Lee, M. W., Loomes, G., & Metcalf, H. 2004, Valuation of health

Desaigues, B., Ami, D., Bartczak, A., Braun-Kohlová, M., Chilton, S., Czajkowski, M., ... & Kaderjak, P. (2011). Economic valuation of air pollution mortality: A 9-country contingent valuation survey of value of a life year (VOLY). *Ecological Indicators*, *11*(3), 902-910.

Desaigues, B., Ami, D., Hutchison, M., Rabl, A., Chilton, S., Metcalf, H., ... & Szántó, R. (2007). Final Report on the monetary valuation of mortality and morbidity risks from air pollution. Deliverable D6, 7.

DHSSPS (2010) "Obesity Prevention Framework 2011-2012" Health Development Policy Branch, Northern Ireland

Edwards, A., Elwyn, G., Covey, J., Matthews, E., & Pill, R. (2001). Presenting risk information a review of the effects of framing and other manipulations on patient outcomes. Journal of health communication, 6(1), 61-82.

European Commission DG Environment (2001) *Recommended interim values for the value of preventing a fatality in DG Environment cost benefit analysis*. www.ec.europa.eu/enveco/others/pdf/recommended_interim_values.pdf

Ferrini, S., & Scarpa, R. (2007). Designs with a priori information for non market valuation with choice experiments: a Monte Carlo study. *Journal of Environmental Economics and Management*, 53: 342–363.

Fit Futures (2006), "Investing for Health," Department of Health, Social Services and Public Safety, January 2006 Ref 126/2005

Foresight (2007), "Tackling Obesities: Future Choices" Project Report October 2007, Department of Innovation Universities and Skills, DIUS/PUB8654/2K/12/07/AR

Gallagher, K. M., & Updegraff, J. A. (2012). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of behavioral medicine*, *43*(1), 101-116.

Gayer, T., Hamilton, J. T., & Viscusi, W. K. (2000). Private values of risk tradeoffs at superfund sites: housing market evidence on learning about risk. Review of Economics and Statistics, 82(3), 439-451.

Gayer, T., Hamilton, J. T., & Viscusi, W. K. (2002). The market value of reducing cancer risk: Hedonic housing prices with changing information. Southern economic journal, 266-289.

Grisolía, J. M., Longo, A., Boeri, M., Hutchinson, G., & Kee, F. (2013). Trading off dietary choices, physical exercise and cardiovascular disease risks. *Social Science & Medicine*, *93*, 130-138.

Grisolía, J. M., Longo, A., Hutchinson, G., & Kee, F. (2015). Applying Health Locus of Control and Latent Class Modelling to food and physical activity choices affecting CVD risk. *Social Science & Medicine*, *132*, 1-10.

Hammitt J.K. & Tunçel T., (2015) Preferences for life-expectancy gains: Sooner or later? Journal of Risk and Uncertainty 51:79–101

Hippisley-Cox, J., Coupland, C., Vinogradova, Y., Robson, J., May, M., & Brindle, P. (2007). Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study. *Bmj*, 335(7611), 136.

Hippisley-Cox, J; Coupland, C; Vinogradova, Y; Robson, J. May, M. and Brindle, P. (2007) "Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study". *BMJ* Volume 335, Number 7611, pp. 332-336

Jenkins, R. R., Owens, N., & Wiggins, L. B. (2001). Valuing reduced risks to children: the case of bicycle safety helmets. *Contemporary Economic Policy, 19*(4), 397-408.

Jette, M., Sidney, K., & Blümchen, G. (1990). Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clinical cardiology*, 13(8), 555-565.

Johnson, F. R., Banzhaf, M. R., & Desvousges, W. H. (2000). Willingness to pay for improved respiratory and cardiovascular health: a multiple-format, stated-preference approach. *Health Economics*, *9*(4), 295-317.

Jones-Lee, M. (1974). The value of changes in the probability of death or injury. Journal of Political Economy, 82(4), 835-849.

Joyce, T., Wallace, A. J., McCarthy, S. N., & Gibney, M. J. (2007). Intakes of total fat, saturated, monounsaturated and polyunsaturated fatty acids in Irish children, teenagers and adults. *Public Health Nutrition*: 12(2):156–165.

Kahneman, D., & Tversky, A. (2013). Prospect theory: An analysis of decision under risk. In Handbook of the fundamentals of financial decision making: Part I (pp. 99-127).

Kessels, R., Goos, P., Vandebroek, M., 2006. A comparison of criteria to design efficient choice experiments. *Journal of Marketing Research* 43 (3), 409–419.

Krupnick, A., Alberini, A., Cropper, M., Simon, N., O'Brien, B., Goeree, R., & Heintzelman, M. (2002). Age, health and the willingness to pay for mortality risk reductions: a contingent valuation survey of Ontario residents. Journal of risk and Uncertainty, 24(2), 161-186.

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74:132–157.

Latimer, A. E., Rench, T. A., Rivers, S. E., Katulak, N. A., Cadmus, L., Hicks, A., ... & Salovey, P. (2008). Promoting participation in physical activity using framed messages: An application of prospect theory. British journal of health psychology, 13(4), 659-681.

Lindhjem, H., Analyse, V., & Navrud, S. (2010). Meta-analysis of stated preference VSL studies: Further model sensitivity and benefit transfer issues.

Lindhjem, H., Navrud, S., Braathen, N. A., & Biausque, V. (2011). Valuing Mortality Risk Reductions from Environmental, Transport, and Health Policies: A Global Meta- Analysis of Stated Preference Studies. *Risk analysis*, *31*(9), 1381-1407

Mahmud, M, (2009) On the contingent valuation of mortality risk reduction in developing countries. *Applied Economics 41* 171-181

McCance, R. A., & Widdowson, E. M. (2002). McCance and Widdowsons The composition of foods/compiled by Food Standards Agency and Institute of Food Research. *Royal Society of Chemistry, Cambridge*, 537.

McHorney, C.A.; War, J.E.; Lu, J.F.R. and Sherbourne, C.D. (1994) "The MOS 36-Item Short-Form Health Survey (SF-36): III. Tests of Data Quality, Scaling Assumptions, and Reliability across Diverse Patient Groups"

Mrozek, J. R., & Taylor, L. O. (2002). What determines the value of life? A meta-analysis. *Journal of Policy analysis and Management*, *21*(2), 253-270.

Müller-Riemenschneider, F.; Reinhold, T.; Berghöfer, A. and Willich, S.N (2007) "Health-economic burden of obesity in Europe*" European Journal of Epidemiology* Volume 23, Number 8, pp. 499-509

Nielsen, J. S., Chilton, S., Jones-Lee, M., & Metcalf, H. (2010). How would you like your gain in life expectancy to be provided? An experimental approach. *Journal of Risk and Uncertainty*, *41*(3), 195-218.

OECD (2011) "Valuing Mortality Risk Reduction in Regulatory Analysis of Environmental, Health and Transport Policies: Policy implications". OECD, Paris, www.oecd.org/env/policies/vsl

O'Keefe, D. J., & Jensen, J. D. (2007). The relative persuasiveness of gain-framed loss-framed messages for encouraging disease prevention behaviors: A meta-analytic review. Journal of health communication, 12(7), 623-644.

Olofsson, S., Gerdtham, U. G., Hultkrantz, L., & Persson, U. (2016). Dread and Risk Elimination Premium for the Value of a Statistical Life. *Working Papers, Department of Economics, Lund University, 22.*

Robinson, L. A., & Hammitt, J. K. (2015). Valuing reductions in fatal illness risks: Implications of recent research. *Health economics*.

Rose, J.M., Bliemer, M.C.J., Hensher, D.A., Collins, A.T., 2008. Designing efficient stated choice experiments in the presence of reference alternatives. Transportation Research Part B: Methodological 42(4), 395-406.

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. Psychological Bulletin, 121, 3–19.

Rothman, A. J., Bartels, R. D., Wlaschin, J., & Salovey, P. (2006). The Strategic Use of Gain- and Loss- Framed Messages to Promote Healthy Behavior: How Theory Can Inform Practice. *Journal of Communication*, *56*(s1), S202-S220.

Ryan, M., Yi, D., Avenell, A., Douglas, F., Aucott, L., Van Teijlingen, E., & Vale, L. (2015). Gaining pounds by losing pounds: preferences for lifestyle interventions to reduce obesity. *Health Economics, Policy and Law*, *10*(02), 161-182

Ryen, L. & Svensson, M. (2015). The willingness to pay for a quality adjusted life year: a review of the empirical literature. *Health economics*, *24*(10), 1289-1301.

Scarpa, R., Campbell, D., & Hutchinson, W.G. (2007). Benefit of landscape improvements: sequential bayesian design and respondent's rationality in a choice experiment, *Land Economics* 83:617–634.

Tanner, C., Medin, D. L., & Iliev, R. (2008). Influence of deontological versus consequentialist orientations on act choices and framing effects: When principles are more important than consequences. *European Journal of Social Psychology*, 38(5), 757-769.

Tolley, G., Kenkel, D., & Fabian, R. (Eds.). (1994). *Valuing health for policy: An economic approach*. University of Chicago Press.

Train, K. E. (1998). Recreation demand models with taste differences over people. *Land Economics*, 74:230–239.

Train, K. E. (2011). *Discrete Choice Methods with Simulation.* Cambridge University Press: Cambridge.

Train, K. E., & Weeks, M. (2005) Discrete choice models in preference space and willingness to pay space. In Scarpa, R., & Alberini, A. (Eds.), *Applications of Simulation Methods in Environmental and Resource Economics*, pp.1-16, Springer, Dordrecht, The Netherlands.

Tsuge, T., Kishimoto, A., & Takeuchi, K. (2005). A choice experiment approach to the valuation of mortality. Journal of Risk and Uncertainty, 31(1), 73-95.

Van Assema, P., Martens, M., Ruiter, R. A., & Brug, J. (2001). Framing of nutrition education messages in persuading consumers of the advantages of a healthy diet. *Journal of Human Nutrition and Dietetics*, *14*(6), 435-442.

Viscusi, W. K. (1993). The value of risks to life and health. Journal of economic literature, 31(4), 1912-1946.

Viscusi, W. K., & Aldy, J. E. (2003). The value of a statistical life: a critical review of market estimates throughout the world. Journal of risk and uncertainty, 27(1), 5-76.

Weinstein, N. D. (1999). What does it mean to understand a risk? Evaluating risk comprehension. *JNCI Monographs*, *1999*(25), 15-20.

WHO (2001) “Obesity: Preventing and managing the global epidemic.” Report on a WHO Consultation, Technical report series, no. 894. WHO World Health Organization, 2001.

WHO (2011). Obesity and overweight fact sheet N° 311. March, World Health Organization, http://www.who.int/mediacentre/factsheets/fs311/en/index.html.

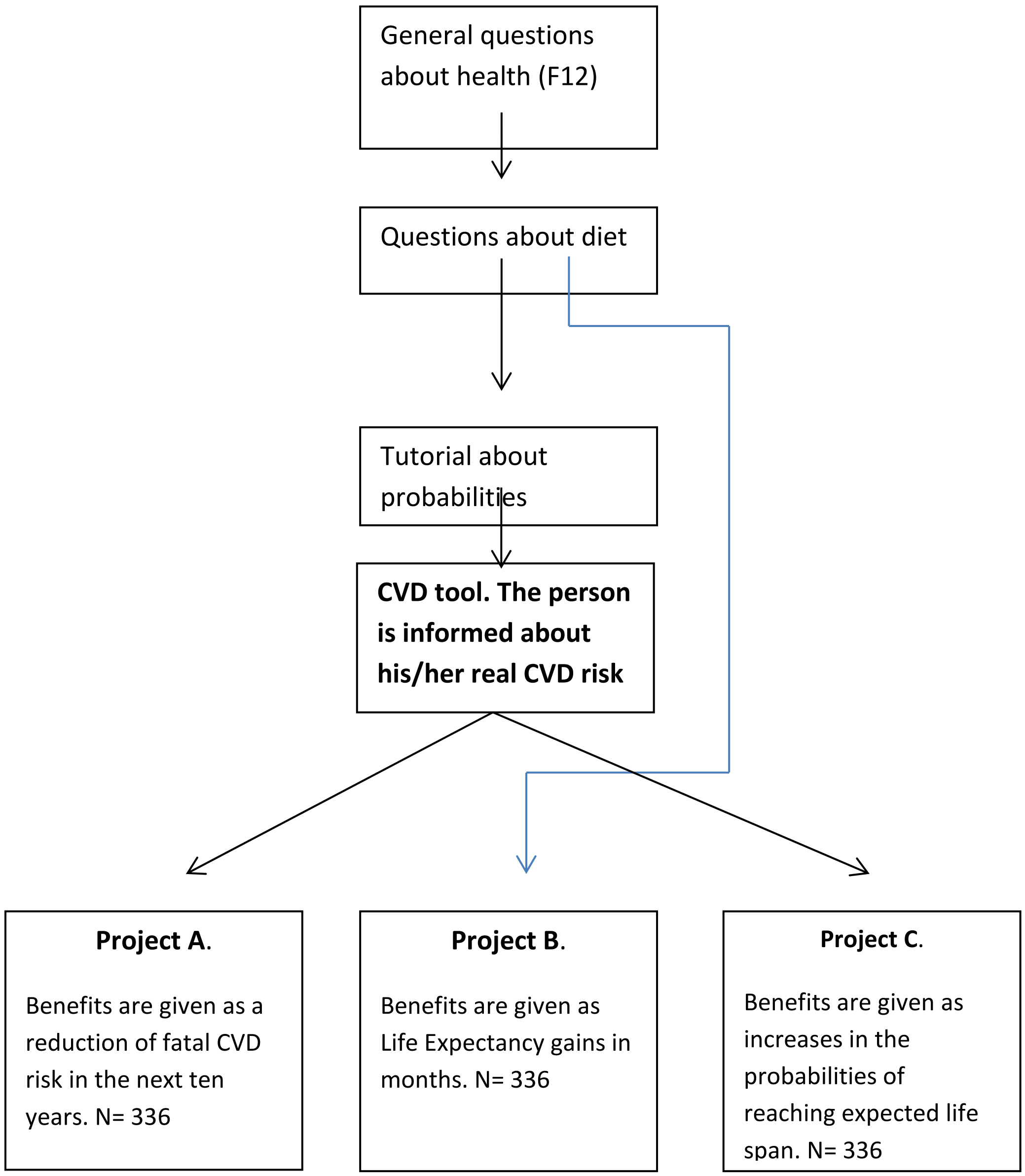

Figure 1: Flowchart of the survey design and questionnaire versions for Outcome Frames A, B and C

Table 1: Structure of the questionnaire

Part	Number of questions	Type of question
General questions about health	19	adapted from the MOS SF36 health questionnaire (Mc Horney et al 1994)
Questions about physical activity	5	
Questions about diet	19	Adaptation of Block questionnaire
Tutorial about probabilities		
CVD tool. The person is informed about his/her real CVD risk		
Choice scenarios	10	• Outcome Frame A: fatal CVD risk in the next ten years. • Outcome Frame B. Life Expectancy gains in months • Outcome Frame C. probabilities of reaching expected life
Follow up questions	2	
Locus control attitudinal questions	5	
Socio-demographic	13	

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CHOICE 3 of 10 - Which option would you choose?

	Current Choice	Option A	Option B
Diet			
Boiled, mashed, instant or jacket potatoes	1-2 times week	1 per month	2-3 times a month
Beef: roast, steak, mince, stew or casserole	1-2 times week	1 per month	2-3 times a month
Savoury pies, eg. Meat pie, pork pie, pasties, steak & kidney pie, sausage rolls	2-3 times a month	1 per month	1 per month
Whole milk	Whole Milk	Skimmed Milk	Semi Skimmed Milk
Spread fat (different from butter) but not low-fat	2-3 times a month	1 per month	1 per month
Expenditure Increase in weekly expenditure in food(£)	No changes	£15 more	£5 more
Exercise Increase in moderate exercise(daily)	No changes	40 minutes	20 minutes
Cardio-vascular risk Your risk of a heart attack in the next 10 years(chances over 100%)	5.00 %	2.50 %	3.75 %
	Current Choice	Option A	Option B
I would choose			

Back OK Clear

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Figure 2: sample of a choice set

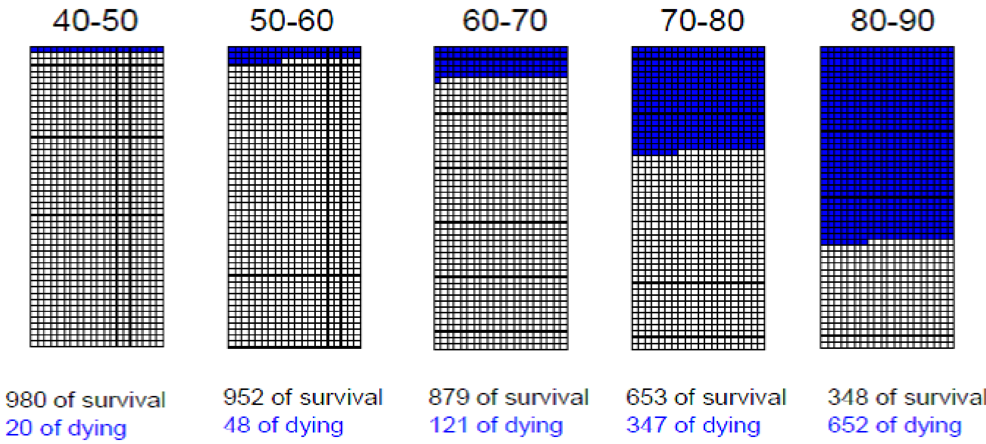

Figure 3: Survival Rates by Age Cohort: Taken from Nielsen et al (2010)

Table 2: How the health benefit part was expressed in Outcome Frame B

	Current choice	**Option A**	**Option B**
Extra months of life expectancy	0	40	30

Table 3: How the health benefit part was expressed in Outcome Frame C

	Current choice	**Option A**	**Option B**
Increase in the probability of reaching your full life span	0	5 in 1,000 (0.5%)	6 in 1,000 (0.6%)

Table 4 Exactly equivalent health gains for choice sets in Outcome Frames A, B and C

	Outcome Frame A: Mortality risk reduction (%)			Outcome Frame B: Life expectancy gain (months)			Outcome Frame C: Probability of reaching your full life span (%)		
choice set	**current**	**A**	**B**	**current**	**A**	**B**	**current**	A	B
1	5	0.75	1.25	0	12	10	66.5	68.2	67.0
2	5	0.75	0.5	0	12	13	66.5	67.6	67.7
3	5	2.5	1.25	0	7	10	66.5	67.0	67.4
4	5	1.25	0.75	0	10	12	66.5	67.0	67.7
5	5	0.5	3	0	13	5	66.5	67.6	67.0
6	5	1.5	1.25	0	10	10	66.5	67.9	68.2
7	5	0.75	0.75	0	12	12	66.5	67.2	67.4
8	5	0.75	2	0	12	8	66.5	68.9	67.4
9	5	3	2	0	5	8	66.5	67.4	68.2
10	5	1.25	0.75	0	10	12	66.5	68.2	68.6

Table 5: Attributes and levels

Attribute		**Levels**		
		Outcome Frame A	**Outcome Frame B**	**Outcome Frame C**
Common part: Proposed behavioral changes	Diet (reduction of the consumption of the respondent's five most unhealthy food items)	Current, light, medium, high and restricted diet		
	Cost (GBP per week)	0, 2, 5, 7, 10, 15, 18		
	Physical Exercise (increase in daily minutes)	0, 10, 20, 30, 40		
Specific gains in terms of health	Health benefits	Percentage risk reduction: 40, 50, 60, 75, 85		
	Displayed as	**Percentage risk** (reduced from status quo)	**Life Expectancy gains** (in months)	**Increases in probability of reaching your full lifespan** (per thousands and percentages)

Table 6: Descriptive statistics on the samples

	Samples			Total samples		Census
	A	**B**	**C**	**Total (n)**	**Total (%)**	**(%)**
Employment status						
Employee	196	202	195	593	**58.52**	**57.75**
$\chi^2 = 0.3519$; df = 2; p = 0.8387						
Unemployed	41	10	22	73	**7,2**	**3.55**
$\chi^2 = 23.4036$; df = 2; p = 0.0001						
Students	2	4	2	8	**0,8**	**0.24**
$\chi^2 = 1.0070$; df = 2; p = 0.6044						
Retired	61	63	76	200	**19,8**	**9.77**
$\chi^2 = 2.4801$; df = 2; p = 0.2894						
Looking after home/family	20	10	23	53	**5,3**	**8.63**
$\chi^2 = 5.5309$; df = 2; p = 0.0629						
Gender						
Men	147	148	163	458	**45,8**	**48.19**
$\chi^2 = 1.9269$; df = 2; p = 0.3816						
Education						
Degree holder	83	59	93	235	**23.3**	**25**
$\chi^2 = 10.1556$; df = 2; p = 0.0062						
	Age (averages)					
Age	50,85	52,24	52,24	51.77		**51,31**
$\chi^2 = 5.2964$; df = 2; p = 0.0708						

The χ^2 test reported shows the result of the Kruskal-Wallis test for the null hypothesis of no difference across the three Outcome Frames.

Table 7: RPL

		Outcome Frame A – Risk Model A		Outcome Frame B - Life Expectancy Model B		Outcome Frame C – Life span Model C	
		Value	St. Err.	Value	St. Err.	Value	St. Err.
status quo	μ	-2.89***	0.578	-7.56***	1.15	-4.49***	1.28
	σ	-4.23***	0.397	20.2***	2.73	5.52***	1.24
status quo * education (degree holders)		0.212	0.708	-8.44***	1.36	-0.371	3.57
status quo * good health (stated)		0.352	0.601	6.91***	1.01	-2.82**	1.21
status quo * male		0.254	0.560	8.50***	1.33	-1.02	1.31
Cost (GBP)	μ	-0.222***	0.0211	-0.160***	0.0226	-0.00796***	0.0113
	σ	0.199***	0.0173	0.169***	0.0263	0.00244***	0.0211
physical activity (additional minutes of moderate intensity exercise)	μ	0.0263***	0.00955	0.0331***	0.00974	0.0239***	0.591
	σ	0.113***	0.0130	0.0248***	0.0154	0.00285	0.00469
Diet (giving up 1 gram of fat)	μ	0.0965***	0.265	0.00230***	0.000971	-0.00971***	0.200
Risk of suffering CVD disease (%)	μ	-0.182***	0.0645				
	σ	0.350***	0.0631				
Life Expectancy (extra months of life)	μ			1.25***	0.162		
	σ			0.865***	0.109		
Life span (Increase in probability of reaching your life span)	μ					-0.140*	0.136
	σ					0.488***	0.0605
Log likelihood		-2397.623		-1560.216		-2197.277	
Sample size n		3360		3360		3360	
Individuals		336		336		336	
ρ2		0.350		0.574		0.401	
Number of parameters k		12		12		12	
Akaike Information Criterion (AIC)		4,813.246		3,138.432		4,412.554	
Bayesian Information Criterion (BIC)		4,868.323		3,193.509		4,467.631	

*** P value < 0.001
** P value < 0.01
* P value < 0.1

Table 8: WTP SPACE MODELS

		Outcome Frame A – Risk Model A		Outcome Frame B - Life Expectancy Model B		Outcome Frame C – Life span Model C	
		Value	**St. Err.**	**Value**	**St. Err.**	**Value**	**St. Err.**
status quo		-2.10***	0.148	-0.646	0.826	-1.25***	0.219
Cost (GBP)	μ	-0.325***	0.0274	-0.188***	0.0305	-0.0205***	0.00825
	σ	-0.355***	0.0280	0.159***	0.0262	0.00574	0.00376
physical activity (Additional minutes of moderate intensity exercise)	μ_w	-0.822***	0.129	9.32	9.60	79.4***	38.9
	σ_w	1.95***	0.198	44.1***	12.4	83.3	79.4
Diet (giving up 1 gram of fat)	μ_w	-4.69***	0.557	-1.26*	0.724	-18.9**	11.6
	σ_w	8.67***	0.921	1.52***	0.715	0.797	0.985
Risk of suffering CVD disease (%)	μ_w	-0.984***	0.145				
	σ_w	0.656***	0.0812				
Life Expectancy (extra months of life)	μ_w			10.1***	2.03		
	σ_w			9.67***	1.86		
Life span (Increase in probability of reaching your life span)	μ_w					-0.655*	0.451
	σ_w					4.39*	3.29
Log likelihood		-2,521.571		-1604.506		-3569.886	
Simple size n		3,360		3360		3360	
Individuals		336		336		336	
ρ^2		0.314		0.563		0.033	
Number of parameters k		9		9		9	
Akaike Information Criterion (AIC)		5,061.142		3,227.012		7,157.772	
Bayesian Information Criterion (BIC)		5,116.219		3,282.089		7,212.849	

*** P value < 0.001
** P value < 0.01
* P value < 0.1