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# Alternative approaches to valuing intangible health losses: the evidence for multiple sclerosis[1]

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**Abstract**

This study uses both risk–risk and risk–dollar approaches to assess intangible health losses associated with multiple sclerosis (MS). Using an estimation approach that adjusts for potential perceptional biases that may affect the expressed risk tradeoffs, we estimated parameters of the utility function of persons with and without MS as well as the degree of subjects' overestimation of the probability of obtaining MS. The sample included subjects from the general population and persons with MS. We found that marginal utility of income is lower in the state with MS than without it. However, the difference in marginal utility in the two states was greater for persons without MS than for those with the disease. Persons with MS overestimated the probability of acquiring MS to a greater extent than did persons within MS. Correcting for overestimation of this probability, the value of intangible loss of a statistical case of MS derived from responses of the general population was US$350,000 to US$500,000. Persons with MS were willing to pay somewhat more than this (D80, I18, J17). 

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[1] This article was written when Chesson was a student at Duke University.


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## 1. Introduction

Economists utilize a variety of methods to value risks to individual health. A substantial literature is devoted to assessing willingness to pay to avoid risks of adverse health outcomes, such as death. This value of life literature is, however, restricted in that many health outcomes of interest are not included in available empirical estimates.

This study utilizes two different approaches to assessing the intangible losses associated with an important class of health effects—those associated with multiple sclerosis (MS). In doing so, we adopt the traditional economic formulation of exploring the willingness to pay for changes in risk and then use these implicit values to assess the implicit value of the expected health outcome. However, our survey explores monetary valuations of health status and risk–risk tradeoffs in which individuals are asked to equate having MS to a fatality risk, which can then be bridged to monetary terms using estimates of the value of life.

This study not only utilizes two different methodological approaches to valuing MS, but it also explores the valuations of two principal subsets of the population —individuals without MS and those who have MS. At one level, examining the valuations of people with the disease is a check on the degree to which a survey provides sufficiently realistic information to enable people without the disease to form reliable judgments. However, even in a well constructed survey, assessing the different valuations is of interest to the extent MS patients have adapted to their disease in a variety of ways that cannot be anticipated before actually experiencing the disease symptoms. An interesting economic issue is the degree to which there is a divergence between the valuations of health status by those who have experienced MS and those who have not. Moreover, if there is such a difference, how should it affect medical decisionmaking and policy interventions? Should we be guided by the evaluations of those who are now healthy but face the risk of the disease, or should we adopt the valuations of those with direct experience with the disease symptoms?

In a separate analysis, we computed the cost to MS patients and their families of medical care, equipment, alterations to home and vehicle, informal care, and lost market and household production (Whetten-Goldstein et al., unpublished). We found that the cost per case was approximately US$2.5 million in 1994. Although high, this estimate excludes much of the loss that is plausibly important to persons with this disease and their families—the pain and suffering, the intermittent nature of the disease, and the lack of hope for cure. Having an estimate of the tangible as well as intangible losses is useful for setting research priorities, and possibly for developing compensation schemes for disease victims.

This study addresses the following specific issues. First, what is the intangible loss estimate? Our preferred estimate of intangible loss is about a fifth or less of our estimate of tangible loss from our previous study. Second, how do estimates of intangible losses based on MS respondents compare to those based on responses

from the general population? Third, how do various methods of eliciting preferences from individuals compare in the aggregate and by experience of respondent with a chronic disabling disease such as MS? We used risk–risk and risk–dollar comparisons. Thus, the metrics for valuing MS are both monetary and in terms of an equivalent mortality risk. Fourth, do estimates of willingness to pay to avoid intangible loss appear to be both valid and reliable? For example, to what extent does experience with a disease help individuals discriminate among symptoms? Fifth, what are determinants of willingness to pay to avoid MS, including the role of income?

Section 2 describes the theoretical framework. In Section 3, we describe the surveys we conducted as well as estimation procedures. Clearly, respondents had problems conceptualizing the very small probabilities of contracting MS in the risk–money tradeoff survey. A fundamental assumption of the risk–risk approach is that subjects perceive the risks accurately. This study introduces a technique for adjusting for potential perceptional biases that may affect the expressed risk tradeoffs. Results are presented in Section 4, which is followed by a discussion of findings and implications in Section 5.

## 2. Theory

We used two approaches to recover the intangible loss associated with MS: risk–dollar and risk–risk. The first approach—risk–dollar tradeoffs—elicits the respondent's willingness to pay to reduce the risk of MS using a series of paired comparisons between cost of living and MS risks. This approach is the survey counterpart of the money–risk tradeoffs that are the focus of the hedonic value of life literature. In the past this technique has provided the basis for valuing a series of environmental health risks, ranging from hand burns to chronic bronchitis. [2]

Although the monetary metric is most familiar to economists, another index of the economic value of health status is the mortality risk one would be willing to incur to avoid some adverse health effect. The mortality risk metric has proven useful in facilitating meaningful risk valuations. [3] Trading off MS risks and fatality risks enables respondents to think in terms of a common attribute, health risks, and to confront tradeoffs in which there are commensurate risks being compared rather than money and very low probabilities of an adverse outcome. One can use value of life estimates from the literature as a bridge to convert the risk–risk tradeoffs into risk–dollar estimates.

[2] For a survey of these studies, see Viscusi (1993).
[3] See Magat et al. (1996).

### 2.1. Risk–dollar tradeoffs

Consider first the theoretical structure of the risk–money tradeoff survey questions. Let $U(Y)$ be the utility of income when the individual is healthy and $V(Y)$ be the utility when a person has MS, where $U(Y) > V(Y)$. Prior empirical research suggests that $U'(Y) > V'(Y)$ for any given level of $Y$ (see, e.g., Viscusi and Evans, 1990), but this constraint will not be imposed. The survey asks respondents to compare two communities: one with a lower cost-of-living and higher probability of MS (community a) and one with a higher cost-of-living and a lower probability of contracting MS (community b). Let $c_b$ be the cost-of-living premium of community b relative to community a and $r$ be the true probability of contracting MS, where $r_a > r_b$. The person is indifferent between the communities where the cost-of-living premium $c_b$ is sufficient to make the expected utility in the two areas equal:

$$r_b V(Y - c_b) + (1 - r_b)U(Y - c_b) = r_a V(Y) + (1 - r_a)U(Y) \quad (1)$$

Let $U(Y) = \beta_1 \ln Y$ and $V(Y) = \beta_2 \ln Y$. Then Eq. (1) can be rewritten [4] as:

$$(1 - r_b)\beta_1 \ln(Y - c_b) + r_b \beta_2 \ln(Y - c_b) = (1 - r_a)\beta_1 \ln Y + r_a \beta_2 \ln Y. \quad (2)$$

Collecting terms and rearranging:

$$\frac{\ln(Y - c_b)}{\ln Y} = \frac{\beta_1 - \beta_1 r_a + \beta_2 r_a}{\beta_1 - \beta_1 r_b + \beta_2 r_b} \quad (3)$$

Survey respondents were asked the same questions in two ways. One set of questions used values for the probabilities and cost of living differentials that were 10 times higher (high probability) than the value used in the other set of questions (low probability). The relationship depicted by Eq. (3) holds for the low and high probability scenarios presented in the survey. To distinguish between the two scenarios, we identify the two scenarios with subscripts L and H, respectively.

To estimate the parameters $\beta_1$ and $\beta_2$, we formed the ratio:

$$\frac{\ln(Y - c_{bL})}{\ln(Y - c_{bH})} = \frac{(\beta_1 - \beta_1 r_{aL} + \beta_2 r_{aL})(\beta_1 - \beta_1 r_{bH} + \beta_2 r_{bH})}{(\beta_1 - \beta_1 r_{bL} + \beta_2 r_{bL})(\beta_1 - \beta_1 r_{aH} + \beta_2 r_{aH})} \quad (4)$$

### 2.2. Risk–risk

The second approach is to establish a mortality risk equivalent of the value of MS. To establish such a value, the survey explores a scenario in which the

[4] This functional form yields decreasing marginal utility of income as income increases and is a convenient form to estimate.

respondent faces a reference mortality risk for a potentially fatal operation, which if successful, completely cures MS. Let $D$ be the probability of dying instantly and painlessly from such an operation. Assume that the individual has MS. Then the level of $D^*$ that equates the utility of having MS with the expected utility if the person undergoes the operation is:

$$V(Y) = (1 - D^*)U(Y) \tag{5}$$

Given $D^*$, $V$ can be computed based on an assumed value of $U$ derived from evidence in the literature on the implicit value of life, which reflects the dollar value of avoiding particular levels of risk (Viscusi, 1993).

### 2.3. Correcting for imperfect risk perceptions

Previous research has demonstrated that individuals systematically overestimate very small mortality risk probabilities. [5] As discussed below, in our application, the probability of contracting MS in a given year is approximately 0.000031 (Granieri et al., 1993). Even if probabilities are provided, they may not be taken at face value and may be updated by respondents in answering questions about risk–dollar tradeoffs. [6] Respondents also may simply be unable to think sensibly about small probabilities and may overestimate these risks once they are called to their attention.

To analyze the updating process, we developed the following method for gauging the extent of overestimation. Let $p(r)$ be the respondent's perceived risk associated with the true probability $r$ stated in the survey. Setting $p(r) = \theta r$, [7] Eq. (4) can be rewritten as:

$$\frac{\ln(Y - c_{bL})}{\ln(Y - c_{bH})} = \frac{(\beta_1 - \beta_1\theta r_{aL} + \beta_2\theta r_{aL})(\beta_1 - \beta_1\theta r_{bH} + \beta_2\theta r_{bH})}{(\beta_1 - \beta_1\theta r_{bL} + \beta_2\theta r_{bL})(\beta_1 - \beta_1\theta r_{aH} + \beta_2\theta r_{aH})} \tag{6}$$

We developed an alternative total risk–dollar approach that combines the risk–risk with the risk–dollar information allows us to recover the parameter $\theta$

[5] See, for example, Fischhoff et al. (1981), Viscusi (1992), and Redelmeier et al. (1993).

[6] This formulation of survey risk responses utilizes a Bayesian decision model and was first introduced in Viscusi (1992) and antecedent publications cited therein. The particular variant of the approach used simplifies the character of the misperception and assumes that it can be characterized by a linear scale factor. More complex formulations were attempted but were not estimable.

[7] Clearly, $p(r) = \theta r$ is one of many possible functional forms of the relationship between perceived and actual risk. A more general form is $p(r) = \gamma + \theta r$. But in comparing the perceived risk for two geographic areas, the constant term drops out by subtraction. If the driving force behind subjects' risk perceptions were $\gamma$ rather than $\theta$, we would not have observed apparent risk misperceptions in our descriptive work (see discussion below) since our analysis was in differences. In early analysis we used the more general risk perception relationship in estimating Eq. (6) and Eq. (8). We often did not obtain convergence. When there was convergence, estimated $\gamma$ was positive, but the estimated $\theta$ was implausibly negative.

without having to estimate the utility function parameters $\beta_1$ and $\beta_2$. Using $p(r)$ instead of $r$, setting $p(r) = \theta r$ and Eq. (5) into Eq. (1) as transformed and simplifying:

$$U(Y)(1 - D^*\theta r_a) = U(Y - c_b)(1 - D^*\theta r_b) \tag{7}$$

Combining the low- and high-probability scenarios and using $U = \beta_1 \ln Y$:

$$\frac{\ln(Y - c_{bL})}{\ln(Y - c_{bH})} = \frac{(1 - \theta D^* r_{aL})(1 - \theta D^* r_{bH})}{(1 - \theta D^* r_{aH})(1 - \theta D^* r_{bL})} \tag{8}$$

By expressing the utilities as a ratio, the utility parameter $\beta_1$ cancels. The parameter $\beta_2$ is not present in Eq. (8) because utility in the sick state is represented by Eq. (5).

## 3. Empirical methodology

### *3.1. Description of survey*

#### *3.1.1. Survey samples*

In the summer of 1995, a marketing firm conducted interviews of a total of 293 shoppers at a shopping center in Greensboro, NC. Because of its representative household mix, the same shopping center has been used as a test marketing site for many national consumer brands and for previous willingness to pay surveys. [8] Respondents had to be at least 18 and were offered US$3 as an incentive to participate. Since the nature of the study was only explained after the interview commenced, nonparticipation plausibly occurred for reasons other than personal views about MS. Potential participants were not told in advance that a computer would be used to administer the interviews. Aversion to use of computers or quantitative analysis was probably also not a reason for not participating. However, as discussed below, it is possible that a disproportionate share of persons with lower time prices were willing to participate.

Also in 1995, interviewers on the research team surveyed a sample of 43 persons with multiple sclerosis who were members of the Eastern North Carolina Multiple Sclerosis Society and lived in Orange and Durham Counties, NC. Potential respondents with MS were first contacted by mail. Of the 225 persons contacted, 19% participated. Although most respondents traveled to Duke University for the interview, some persons who were too disabled to travel were interviewed in their homes. We recorded demographic characteristics, health, functional status, type of MS the respondent had, and income to allow us to adjust for these factors. Since respondents were only told about the survey's purposes in

[8] All of the EPA-sponsored health risk valuation studies reviewed in Viscusi (1993) utilized this site.

general terms, it is doubtful that participation varied directly to willingness to pay to avoid MS. However, sicker people may have been less likely to participate due to lack of interest in participating in any survey. One may hypothesize that sicker individuals may have greater willingness to pay to avoid MS. Excluding such individuals may bias our estimates downward.

*3.1.2. The interviews*

Each respondent viewed one of four randomly selected videotapes depicting an actual patient with one of the four principal types of MS. MS is a chronic neurological disease affecting mobility, sensation in limbs, sight, speech, control of bowel and bladder, sexual function, and cognition (Goodkin, 1992; Loomes and McKenzie, 1989; Martyn, 1991; Mathews et al., 1991; Miller and Hens, 1993; Mitchell, 1993). MS may cause awkward movements and even sudden laughing or other mood changes, as well as extreme fatigue. The disease is often accompanied by pain. Prevalence of MS in the US is between 250,000 and 350,000 persons (Anderson et al., 1992). Each year about 8000 persons acquire MS (Granieri et al., 1993). MS is more common among whites, females, those of high economic status, and urban residents (Kurtzke et al., 1979; Paulley, 1975). For reasons that are not well understood, the disease is more prevalent in higher latitudes (Weinshenker et al., 1989). In the video, scripts were read by a person with that type of MS. To avoid cognitive overload (see Torrance, 1986), the videotaped descriptions were limited to 2 min. Following the videotape presentation, surveyors conducted interviews using an interactive computer program in order to avoid problems of interviewer bias and to promote honest revelation of preferences. The computer program utilized a sequence of paired comparisons to greatly facilitate establishing points of indifference. Interactive computer programs have been used successfully in several previous studies.[9] Previous work also has shown that subjects are better able to recall information provided in a multimedia format compared to receiving the same information in written format alone (Goldstein et al., 1994).

The interviews consisted of five parts: (1) ratings of the importance of avoiding 13 symptoms of MS, using a visual analog scale; (2) ratings of the respondent's current health and of having the type of MS depicted on the videotape for 1 yr, 5 yrs, and for the rest of one's life, also on a visual analog scale; (3) questions to determine the risk–dollar tradeoff between a lower cost-of-living in an area and a higher probability of acquiring MS; (4) questions to determine the risk–risk tradeoff between having MS for the rest of one's life and having an operation that, if successful, completely cures MS but has a particular probability of death–risk–risk tradeoff; and (5) questions about the respondent's background, including

[9] Several of the studies surveyed in Viscusi (1993) used this interactive program approach, as did Viscusi et al. (1991) and Magat et al. (1996). Also see Goldstein et al. (1994).

family income, educational attainment, and current health on a five-point Likert scale ranging from 'poor' to 'excellent.'

Respondents were asked to assume that all pecuniary loss associated with the disease was covered. They were reminded of this several times during the survey. Thus, the questions pertained to nonpecuniary loss from MS.

*3.1.3. Risk–dollar and risk–risk questions*

Respondents were asked two sets of risk–dollar questions, a low-probability scenario and then a high-probability scenario (Table 1). In the *low-probability risk–dollar scenario*, respondents were asked to compare two locations, a and b. In area a, the probability of contracting MS was stated to be 40 million/yr. In area b, the probability of MS was 30 million, but cost-of-living was said to be US$100 higher per year than in location a.

The survey established indifference was established by either increasing the probability in b from 30 million or by decreasing the cost-of-living differential between b and a. Thus, if the respondent initially preferred a, then the cost-of-living difference decreased in increments of US$10 until a preference reversal occurred or the cost of living difference reached US$10. Alternatively, if the respondent preferred b, the probability of contracting MS in b increased in increments of 1 million until a preference reversal occurred or until the risk presented reached 39 per million. Left censoring and right censoring occurred in 8.9 and 18.2% of cases, respectively.

In the *high-probability risk–dollar scenario*, respondents were again asked to choose between the two locations. However, the probability of MS was said to be

Table 1
Risk–dollar and risk–risk questions

Part A. Risk–dollar

Choose which area you like better

| | Area A | Area B |
|---|---|---|
| Cost of living (per year) | same as your area | US$100 higher |
| Risk of getting MS(per year) | 40 out of a million | 30 out of a million |

Which area would you rather live in?
1. Area A
2. Area B
(Press the number that goes with your answer.)

NOTE: The information in this table was provided piece-by-piece on the computer screen at a pace determined by the subject. That is, the cost of living in Area A was presented, and, when the subject indicated readiness to proceed, the cost of living in Area B was presented, and so on.

Part B. Risk–risk

Would you choose to have the operation if the chance of dying was 15%?
1. YES, I would have the operation.
2. NO, I would not have the operation.
(Press the number that goes with your answer.)

400 million in a and 300 million/yr in b, and the annual cost-of-living difference was initially said to be US$1000 higher in b than in a. The underlying economic hypothesis is that individual willingness to pay per unit risk reduction should decrease with the extent of the risk change. In this instance the willingness to pay in the high risk scenario should be less than ten times the willingness to pay the low risk scenario. As with the initial values, to find indifference, increments were 10 times the increments used for the low-probability scenario. The same stopping rule (multiplied by 10) described above was used. Left censoring and right censoring occurred in 9.5 and 14.9% of cases, respectively. The higher percentage

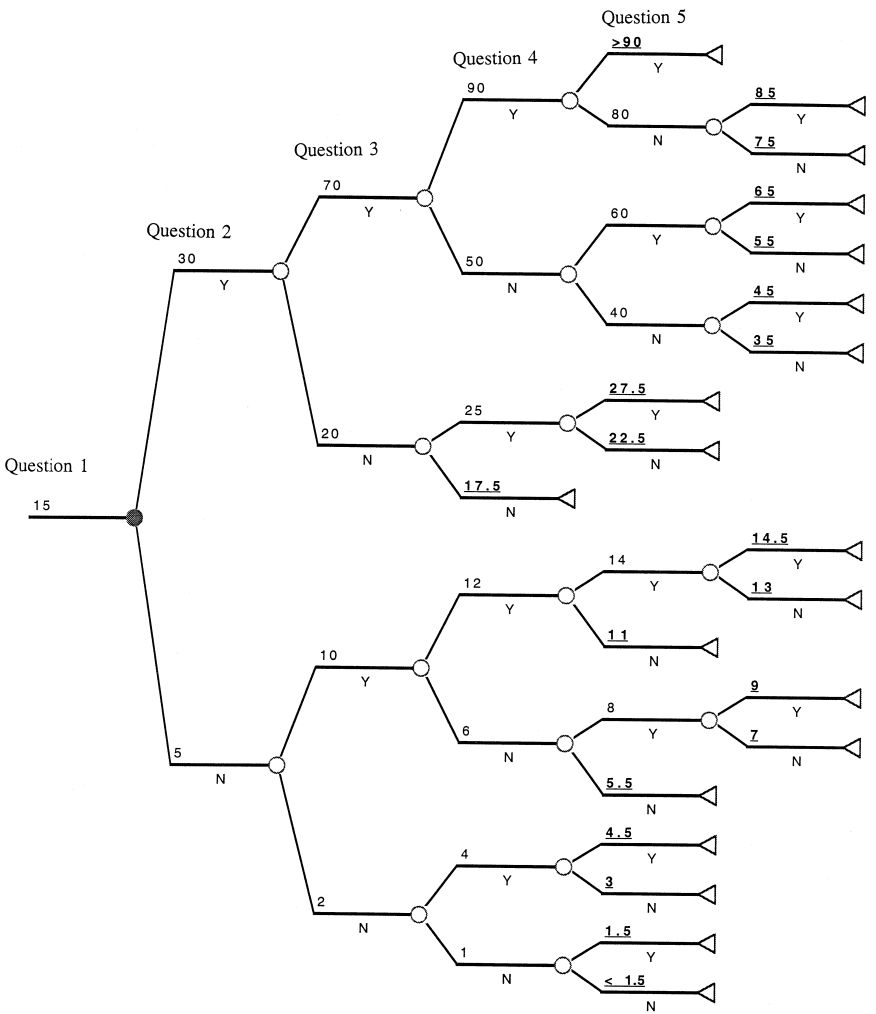


Fig. 1. Algorithm for determining the indifference point for an operation.

of right-censored cases for the low-probability scenario reflects diminishing marginal willingness to pay as the probability of harm increases.

In the *risk–risk scenario*, respondents were asked to assume that they had MS and that a painless operation exists that would either completely cure their MS or kill them instantly (Table 1). The probability of dying was adjusted until the respondent became indifferent between having and not having the operation. The individual probability of death was initially set at 0.15. (A pretest of our survey revealed that half of the respondents would choose the operation at this probability.) The risk was adjusted according to the algorithm described in Fig. 1 until a point of indifference was established. There was a minimum of three and a maximum of five iterations. Final values are shown as end points on the tree. [10] For example, if the respondent said she/he would undergo the operation with a 0.15 probability of dying, the second question asked if the subject would undergo the operation if the probability of dying were 0.3, and so on.

### *3.2. Estimation*

#### *3.2.1. Utility functions*

We estimated utility function parameters $\beta_1$ and $\beta_2$ and the risk misperception parameter $\theta$ from Eq. (6) with nonlinear regression. The dependent variable was the ratio of the natural log of income minus the cost-of-living difference that made the respondent indifferent between the two communities for the low risk scenario to the natural log of the corresponding difference for the high risk scenario. The values of $(Y - c_b)$ and the probabilities ($r$'s) were provided by the survey. We could recover $\theta$ because we elicited responses from the two scenarios, and $\theta$ varied among respondents.

Eq. (8) contains $\theta$, but not $\beta_1$ and $\beta_2$. We obtained an estimate of $\theta$ using nonlinear regression.

To estimate utility function and risk perception parameters, we did not include other covariates, such as respondent age and health. To include such variables would have greatly increased the complexity of the estimation process. In the analysis we now describe, we assessed effects of other factors as determinants of willingness to pay to avoid MS.

#### *3.2.2. Risk–dollar equations*

To explore the determinants of the risk–dollar tradeoffs, we estimated equations with the respondent's willingness to pay to avoid the nonpecuniary loss

[10] We stopped the iterative process at 'below 1.0%' and 'above 90%.' Overall, 9.2% of respondents to our surveys answered below 1.0%, and 20.8% of respondents answered above 90%. Previous work has shown that 28% of people rate being confined to wheelchair for the rest of their life as being 'as bad as death' and 24% rate it as 'worse than death' (Tolley et al., 1994). Thus we were neither surprised nor concerned that one fifth of the sample would incur a 90% or greater risk of death to avoid MS.

associated with MS as the dependent variable with a specification not based on our models. Separate equations were estimated based on responses to the low- and the high-probability scenarios. Willingness to pay was for a 0.00001 probability of MS. The responses to the high-probability scenario were scaled to be in the same units as the low-probability scenario. For example, a subject willing to pay US$100 for a two in one million risk reduction was recorded as willing to pay US$500 for a one in a hundred thousand risk reduction. Key explanatory variables were: family income; educational attainment; and a binary variable identifying respondents who had MS. To reduce collinearity between income and education, we replaced the continuous income variable with a binary variable identifying those in the top half of respondents' income distribution. Such persons had family income of over US$45,000 per year. When information on income or education was not obtained, we set the value of the variable to zero; in such cases, the value of a binary variable signifying that the value was missing was set to one. [11] Other explanatory variables were: age (set to zero when missing); binary variable identifying observations for which age information was missing; binary variables for race (white = 1), gender (female = 1), and whether or not the respondent had children; and continuous variables for health, ranging from worst (0) to excellent (100), and household size.

To account for right censoring, we estimated a hazard model. We experimented with several alternative distributions, log logistic, log normal, normal, and Weibull. Based on a comparison of log likelihood values, the Weibull distribution yielded the best fit. We did not account for left censoring because there were few left censored values. Ordinary least squares estimates, not shown, are quite similar to the Weibull estimates that we present.

#### *3.2.3. Risk–risk equation*

We also estimated equations for the probability of death from the operation that made the respondent indifferent between having the operation and having MS. We used the same equation specification as in the risk–dollar analysis. We used ordinary least squares. Accounting for right censoring (20.8% at the upper bound) did not affect the parameter estimates.

## 4. Results

### *4.1. Comparison of general and MS samples*

Respondents with MS had higher family income, were more educated, were more likely to live alone, to be white, female, and to have children than the

[11] The means in Table 2 include observations with income and education missing coded as zero.

Table 2
Sample characteristics: means and standard deviations

| | Full sample ($N = 336$) | General sample ($N = 293$) | MS sample ($N = 43$) |
|---|---|---|---|
| Family income before tax | 44,680 (35,749) | 43,012 (31,090) | 54,597 (55,570) |
| Incoming missing | 0.21 (0.41) | 0.23 (0.42) | 0.12[b] (0.32) |
| Education (years) | 13.1 (2.7) | 12.7 (2.4) | 16.1[a] (2.3) |
| Education missing | 0.015 (0.121) | 0.017 (0.130) | 0 (0) |
| Married | 0.52 (0.50) | 0.52 (0.50) | 0.49 (0.51) |
| Live alone | 0.19 (0.39) | 0.17 (0.37) | 0.30[a] (0.47) |
| Household size | 2.77 (1.51) | 2.85 (1.53) | 2.26[a] (1.24) |
| Age | 38.97 (15.29) | 37.69 (15.47) | 47.42[a] (10.88) |
| Age missing | 0.03 (0.16) | 0.03 (0.17) | 0 (0) |
| Over 65 years in age | 0.07 (0.25) | 0.07 (0.26) | 0.05 (0.21) |
| White | 0.69 (0.47) | 0.67 (0.47) | 0.81[c] (0.39) |
| Female | 0.55 (0.498) | 0.52 (0.50) | 0.79[a] (0.41) |
| Have children | 0.55 (0.50) | 0.52 (0.50) | 0.74[a] (0.44) |
| Have MS | 0.13 (0.34) | 0 (0) | 1[a] (0) |
| Rank of current health | 73.79 (18.93) | 75.70 (18.41) | 60.74[a] (17.38) |

Measures of statistical significance compare the MS sample with the general sample.
[a]Two-tailed *t*-test significant at 1%.
[b]Two-tailed *t*-test significant at 5%.
[c]Two-tailed *t*-test significant at 10%

general population interviewed by mall intercept (Table 2). Compared to a national sample of persons with MS, we recently conducted (Whetten-Goldstein et al., unpublished), our MS sample is similar in terms of educational attainment, race, and gender. However, the 43 respondents with MS in this study had higher family income than our national sample of persons with MS.

The mean family income in our general sample translates into a per capita income of US$15,091. This was 30% lower than the mean per capita in the US and 23% lower than the mean per capita in North Carolina (U.S. Department of Commerce, 1995).

### *4.2. Responses to risk–dollar questions*

Based on the responses to the risk–dollar questions, there was substantial variation in willingness to pay to avoid MS (Fig. 2a and b). We scaled the responses so that the willingness to pay measure was the dollar amount that the subjects equated with an incremental probability of acquiring MS of 1 in 100,000. For the low-probability scenario, the mode was for the general population in the US$100 to US$249 range. The median was US$105. Most respondents gave values between US$50 and US$250. For the high-probability scenario, the mode was lower—in the US$50 to US$99 range—and the median was US$95.

Overall, respondents with MS were willing to pay much more to avoid acquiring the disease. For purposes of answering the risk–dollar questions, the

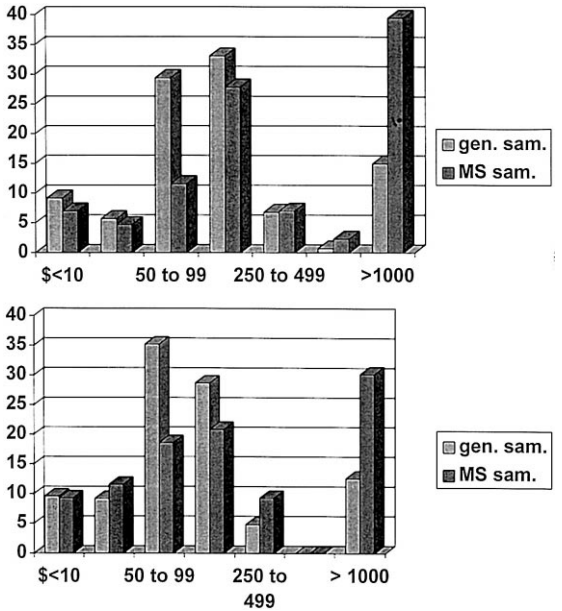


Fig. 2. (a) Willingness to pay to avoid 0.00001 probability of MS-low probability scenario. (b) Willingness to pay to avoid 0.00001 probability of MS-high probability.

survey asked them to suppose that they did not have the disease. The median willingness to pay was US$222 and US$153 for the low- and high-risk scenarios, respectively. The proportion of respondents willing to pay US$1000 or more to avoid an increase of 1 in 100,000 was more than twice that of the general sample.

Even estimates from the general sample imply substantial willingness to pay to avoid MS. The median values of US$105 and US$222 translate into a willingness to pay to avoid the intangible loss of a statistical case of MS of US$10.5 million and US$22.2 million for the general population and for persons with MS, respectively. These values are well above published estimates of the value of life (US$3 to US$7 million: Viscusi, 1993). Although substantially higher, there was no statistically significant difference in mean willingness to pay between the low- and high-probability scenarios.

### *4.3. Responses to risk–risk questions*

Likewise, there was considerable variation in responses to the risk–risk question (Fig. 3). For purposes of responding to this question, subjects were asked to imagine that they had MS. The probability of death from the operation that made subjects indifferent in the general survey between having MS and having the operation was 0.45 at the median. There were many respondents who were

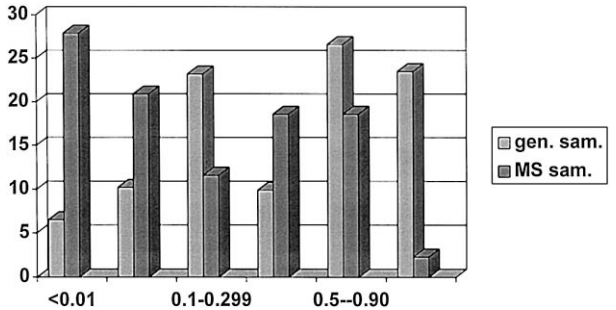


Fig. 3. Probability of death accepted to be totally cured of MS.

indifferent at probabilities of death in the 0.1–0.3 range and in the range above 0.5. In comparison, a similar study which asked respondents to trade-off risk of death in an automobile accident with risk of chronic bronchitis found that the risk of chronic bronchitis was worth 32% of the comparable risk of death, using the median tradeoff rate (Viscusi et al., 1991). Using a value of life of US$3 to US$7 million (Viscusi, 1993) and the median probability from our mall survey, the value of avoiding the nonpecuniary loss associated with MS ranges from US$1.4 to US$3.2 million, far less than the values derived from the risk–dollar questions. This is the reverse of what was found for chronic bronchitis, where the median risk–risk tradeoff (US$2.3 million) was four times higher than the risk–dollar tradeoff (US$457,000) (Viscusi et al., 1991).

Respondents with MS were much more resistant to undergoing the operation. The median point of indifference was 0.18. Almost a third of the observations were left censored. Almost half were under 0.1. In contrast to the result from the risk–dollar questions, responses from the risk–risk analysis imply that persons with MS place less disutility on having the disease than do others who learned about the disease from a brief videotape description.

### *4.4. Implications of findings*

Two findings imply risk misperceptions: (1) the implausibly high willingness to pay to avoid MS obtained from the risk–dollar responses; and (2) the inconsistency in values obtained from the MS versus other respondents to the risk–dollar versus the risk–risk questions. These results may imply that persons with MS have a higher utility in the state of having MS than others think they would have, and/or persons with MS see the possibility of getting MS as a more realistic possibility. To the extent that the above risk–dollar values do not take account of right censoring, they underestimate the true values.

These results are consistent with our seemingly contradictory empirical finding. People with MS are willing to pay more money to reduce the risk of MS, but are

willing to incur a lower probability of death to cure MS. This result would occur if MS lowers the utility level $V(Y)$ with MS by a smaller amount for the MS patients, as the risk–risk results suggest, and if MS has a smaller effect on the marginal utility of money $V'(Y)$ in the MS state. The latter is reflected in the MS subjects' higher willingness to pay to avoid MS, if indeed the marginal utility of income is higher in the healthy than in the sick state as empirical evidence suggests (Viscusi and Evans, 1990). Thus, these two sets of empirical results do not necessarily contradict rational behavior.

### *4.5. Regression analysis*

#### *4.5.1. Utility function and risk misperception parameters*

We estimated the parameter $\theta$ separately the general and the MS samples (Table 3). Using Eq. (6), persons in the general sample overestimated the probability of acquiring MS in a year by a factor of 30. With the alternative approach which combined information from risk–risk questions with risk–dollar information, the overestimation factor was 39. Both estimates of $\theta$ were statistically significant at the 0.01 level (two-tail test). MS respondents overestimated this probability by a factor of 71, based on the method using Eq. (6). The approach based on Eq. (8) yielded an overestimation factor of 47. The utility function parameters were statistically significant at the 1% level. Estimates of $\beta_1$ were 9843 for the general population and 3000 for the MS patients, while estimates of $\beta_2$ were 829 and 2002, respectively. Given the functional form, $U'(Y) = \beta_1/Y$ and $V'(Y) = \beta_2/Y$, for the general sample, marginal utility in the healthy state was over 10 times the marginal utility with MS. For the MS sample, marginal utility was roughly 50% higher in the healthy state. These marginal utility values are an instructive measure of welfare loss since they indicate how much the welfare benefit of financial resources in diminished by MS. The results imply that

Table 3
Utility function and risk misperception parameter estimates

| | | Method based on Eq. (6) | Method based on Eq. (8) |
|---|---|---|---|
| *Extent of overestimation ($\theta$) (times overestimated)* | | | |
| General | | 30.3[a] (1.4) | 38.6[a] (4.4) |
| Have MS | | 71.0[b] (24.9) | 47.0[a] (21.0) |
| *Utility function parameters* | | | |
| General | $\beta_1$ | 9843.4[a] (3067.3) | – (–) |
| | $\beta_2$ | 828.7[a] (7.1) | – (–) |
| Have MS | $\beta_1$ | 2999.5[a] (5.2) | – (–) |
| | $\beta_2$ | 2002.2[a] (4.2) | – (–) |

[a]Two-tailed *t*-test significant at 1%.
[b]Two-tailed *t*-test significant at 5%.

Table 4
Willingness to pay to avoid intangible loss of MS adjusting for misperceived risk (US$)

| | Method based on Eq. (6) | Method based on Eq. (8) |
|---|---|---|
| *General sample* | | |
| Low-probability scenario | 510,000 | 419,000 |
| High-probability scenario | 420,000 | 346,000 |
| *MS sample* | | |
| Low-probability scenario | 583,000 | 881,000 |
| High-probability scenario | 375,000 | 566,000 |

persons with MS were less averse to having MS than were persons in the general sample. This pattern is consistent with our risk–risk results which imply that persons with MS have a higher relative utility in the sick state. These findings are also consistent with other research showing higher marginal utility in the healthy state (see, e.g., Viscusi and Evans, 1990).

Table 4 compares our different estimates. Both for the general public and MS patients, our raw risk–dollar estimates result in implausibly high estimates of willingness-to-pay to avoid MS—in excess of US$10 million per case of MS for the general public and more than twice this amount for MS patients. When we corrected for biases in the ways respondents perceived the risk data presented to them, however, we got results more consistent with value-of-life reference points: roughly US$350,000 to US$500,000 per MS case for the general public and US$375,000 to US$880,000 for MS patients.

*4.5.2. Alternative specifications: risk–dollar*

Table 5 presents the regression results, where the first two columns pertain to risk–dollar estimates. Several parameter estimates were statistically significant at conventional levels. Results based on the alternative distributions (not shown) were quite similar. As in the univariate analysis, persons with MS were willing to pay more money to avoid contracting the disease. This analysis holds the subject's general health constant. Persons in better health had a higher willingness to trade money for a lower likelihood of getting MS.

Higher income persons were willing to pay more to avoid MS, based on the coefficient on 'Rich' in the regression for the low-probability scenario. This result is consistent with the estimated positive income elasticity of the valuation of health and risks to health found in a variety of studies. [12]

The coefficient on education was positive and statistically significant in one of the two regressions, implying both greater willingness to pay to avoid MS and a

[12] See Viscusi and Evans (1990) and the references contained therein.

Table 5
Regression results

| Explanatory variables | Risk–dollar willingness-to-pay | | |
|---|---|---|---|
| | Low-probability scenario | High-probability scenario | Risk–risk probability |
| Have MS | 347.1[a] (108.1) | 273.1[a] (99.8) | −0.34[a] (0.07) |
| Health | 3.9[a] (1.5) | 4.3[a] (1.5) | −0.001 (0.001) |
| 'Rich' | 125.2[c] (67.4) | 68.7 (64.6) | −0.00 (0.04) |
| Education | 25.5[b] (13.1) | 18.1 (12.7) | 0.021[b] (0.009) |
| Education missing | −34.9 (264.0) | 127.2 (274.8) | −0.046 (0.21) |
| Age | −5.0[b] (2.3) | −1.1 (2.2) | 0.002 (0.002) |
| Age missing | −13.4 (217.7) | −125.5 (203.7) | 0.23 (0.16) |
| Single | 94.8 (69.8) | 57.4 (68.3) | 0.088[c] (0.049) |
| Female | 127.9[b] (61.8) | 88.9 (58.5) | −0.069 (0.043) |
| Have children | 168.3[b] (70.9) | 179.1[a] (69.6) | 0.041 (0.050) |
| Household size | −33.4 (20.6) | −22.5 (19.3) | −0.016 (0.014) |
| Intercept | −65.5 (233.1) | −234.9 (222.3) | −0.33[b] (0.16) |
| Scale | 455.1[a] (20.6) | 445.1[a] (19.4) | −(−) |
| Log likelihood | −2183.5 | −2248.7 | |
| | | | $R^2 = 0.10$ |
| | | | $R^2(C) = 0.07$ |
| | | | $F(12,323) = 3.1$ |

[a]Two-tailed *t*-test for significance of parameter estimates significant at 1%.
[b]Two-tailed *t*-test for significance of parameter estimates significant at 5%.
[c]Two-tailed *t*-test for significance of parameter estimates significant at 10%.

greater disutility from having the disease. Education may be a proxy for wealth, cognitive abilities, and/or may simply affect preferences. Also, age, being female, and having children had statistically significant impacts in one or both regressions.

*4.5.3. Alternative specification: risk–risk probability*

The risk–risk estimates in the final column of Table 5 indicate the determinants of the respondent's willingness to incur fatality risks to cure MS. Persons with MS were less willing to undergo a hypothetical operation to cure MS. Whereas respondents with MS were more willing to sacrifice money to avoid MS, they were less willing to risk death to cure MS.

Neither health nor income affected the stated willingness to undergo surgery. The lack of statistical significance for income provides empirical support for the above assumption that $D$ does not vary over small changes in income (see Eq. (5)). As in the risk–dollar analysis, the positive coefficient on education suggests that more educated persons attach a greater weight on not having MS. The only other statistically significant coefficient is the one on the binary for marital status, which implies that single persons are less willing to trade off life expectancy in exchange for relief from MS.

Table 6
Willingness to pay to avoid MS adjusting for misperceived risk

| | | $U = \gamma Y^{\alpha}$ | | | | |
|---|---|---|---|---|---|---|
| | $U = \beta \ln Y$ | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *Exent of overestimation (Θ)(times overestimated)* | | | | | | |
| General (sd) | 32.5 (21.1) | 10.5 (8.4) | 31.8 (25.1) | 53.4 (41.8) | 75.3 (58.4) | 97.6 (75.0) |
| Have MS (sd) | 17.3 (51.3) | 2.8 (20.7) | 8.5 (62.1) | 14.5 (103.3) | 20.7 (144.4) | 27.1 (185.4) |
| *Low risk baseline (US$ millions)* | | | | | | |
| General (sd) | 0.95 (0.51) | 2.92 (1.58) | 0.97 (0.52) | 0.58 (0.31) | 0.41 (0.22) | 0.32 (0.17) |
| Have MS (sd) | 4.29 (0.96) | 26.79 (6.02) | 8.74 (1.96) | 5.14 (1.15) | 3.59 (0.81) | 2.74 (0.62) |
| *High risk baseline (US$ millions)* | | | | | | |
| General (sd) | 0.79 (0.44) | 2.43 (1.36) | 0.80 (0.45) | 0.48 (0.27) | 0.34 (0.19) | 0.26 (0.15) |
| Have MS (sd) | 3.55 (0.67) | 22.16 (4.20) | 7.23 (1.37) | 4.23 (0.81) | 2.97 (0.56) | 2.27 (0.43) |

#### *4.5.4. Willingness to pay to avoid MS, accounting for right censoring*

Accounting for right censoring using hazard analysis raised our estimates of subjects' willingness to pay to avoid MS appreciably. The median values for the low- and high-probability scenarios to avoid a 1 in 100,000 chance of MS were US$343 and US$294, respectively. The mean values were US$363 and US$301.

Table 6 shows the willingness to pay to avoid MS adjusting for misperceived risk.

### *4.6. Validity and reliability of estimates*

Both to instruct respondents in the survey approach and to provide some indication of their ability to follow instructions, we examined the logic of responses to a few questions. For example, having MS for a longer time period is unambiguously worse than having it for a shorter time period. Less than 3% of respondents gave more favorable ranking to having MS for a longer than a shorter time period. None of these respondents changed their answers when presented with their inconsistency. A more difficult comparison was between two communities, one better than the other both in terms of having a lower cost of living and a lower incidence of MS. Almost 12% of respondents selected the dominated alternative.

To evaluate reliability, we also compared responses at the extremes to the risk–risk and two risk–dollar scenarios. About 4% of the pooled (general and MS) sample were indifferent between having and not having the operation at a probability of death greater than 0.9, but were not willing to pay US$1 to avoid a 1 in 100,000 chance of getting MS. The simple correlation between the responses to the two questions was 0.72. Two-thirds of respondents giving left- or right-censored responses to the low-probability scenario also did so for the high-probability scenario.

We asked respondents to rate the importance of avoiding certain signs and symptoms of MS. Respondents to the general survey were not able to distinguish between signs and symptoms of MS. They rated them all as being quite bad and with little variation among them. However, individuals with MS rated some symptoms as being much worse than others. The worst symptoms were: blurred vision, loss of bladder control, and not being able to drive. By contrast, a numbing sensation, needing to walk with a cane, and difficulty writing were not viewed as serious.

## 5. Discussion

Willingness-to-pay survey studies pose several critical issues. First, are the results believable? Second, do valuations differ among those with and without the disease and if so, which set should be used for making policy? Third, does willingness-to-pay depend on income and if so, how should this be incorporated into policy decisions?

In theoretical terms, the willingness-to-pay evidence is superior to the alternative of deriving willingness-to-pay using an analog scale rating quality of life with and without MS. Value is only meaningful if it is expressed relative to other goods or services that must be sacrificed (Fabian, 1994). Previous work has shown that patient utilities for different disease states typically are lower using an analog scale than when the same patients are asked to rate disease states using either standard gamble or time tradeoff (Bass et al., 1994; Nease et al., 1995).

However, a major impediment to use of willingness to pay has been concern that subjects are unable to provide valid and reliable willingness to pay estimates. We examined validity and reliability from several perspectives. First, crucial to the concept of willingness to pay is the notion of a tradeoff. One in eight selected a dominated alternative in the risk–cost comparisons. A similar comparison by Viscusi et al. (unpublished) of risks of various hazards yielded a slightly higher percentage. Overall, it appears that the vast majority of respondents grasped the notion of a tradeoff. Second, we appeared to get very *consistent* responses, in that very few respondents were willing to face a high risk of death to avoid MS but were willing to pay only a small amount to avoid this risk. In general, there was a high degree of consistency between responses to the two risk–dollar scenarios.

However, the respondents to our survey had difficulty dealing cognitively with very small probabilities of occurrence. That is, in comparing our risk–risk to risk–dollar estimates, it was clear that respondents tended to systematically overestimate the risk of getting MS—a prospect that could arise in contingent valuation of any disease such as MS with low incidence rates. This was in spite of the use of visual aids. Our findings serve to emphasize the importance of correcting for overperception of risk, along with a method for doing so. A methodological contribution of our study to a growing body of health valuation

studies is that we have shown how to combine responses from both risk–dollar and risk–risk questions to adjust for such misperceptions in computing the value of intangible loss as a cross-check on estimates obtained solely from responses to risk–dollar questions. Aside from the theoretical rationale, multiple measures may improve confidence in the estimates (Torrance, 1987).

Respondents in the general sample had difficulty discerning the severity of various symptoms of MS. Further, the video seen did not affect response to the valuation questions. The next step would be to improve on our survey methodology before concluding that subjects with no experience with a disease are capable of making refined comparisons about severity.

We found no statistically significant differences in either willingness to pay or in willingness to undergo the operation recording to the video (type of MS) shown. But there were no statistically significant differences in responses from the MS patients who had different types of MS either. So it is not clear how to interpret this negative finding.

The issue of whether willingness-to-pay estimates differ among those with and without disease is critical. Several prior studies of preferences for health states have found a high degree of correspondence between ratings provided by patients and those of the general public. These include studies of arthritis (Balaban et al., 1986) and cancer (Nerenz et al., 1990). Similarly, ratings compiled by the Oregon Health Services Commission showed that assessments of quality of life were very similar for those who had ever been confined to a wheelchair or walker compared to those who had not (Kaplan, 1995). To our knowledge, Krupnick and Cropper (1992) is the only study to have gauged the effect of familiarity with a disease on health risk valuation using a contingent valuation approach. In their study, they compared willingness to give up income to reduce the risk of chronic bronchitis and, alternatively, willingness to increase their risk of auto death to reduce risk of the disease between a sample of persons who had relatives with the disease and a general sample. On average, prior contact with the disease increased willingness to forego income, but it had no effect on the risk–risk tradeoff.

They concluded that responses to risk–risk tradeoffs may be more stable than responses to risk–dollar choices. Our risk–dollar results confirm their finding of higher willingness to pay among those with the disease. However, we found that patients with MS were on average *less* willing to undertake the operation. Thus, Krupnick and Cropper's finding about relative stability of risk–risk choices does not generalize to this situation. Our finding that the general public tends not to be able to discriminate well in rating the different symptoms of MS implies that it is difficult to obtain very refined judgments from individuals who do not have direct personal experience with the disease. This would argue for using the willingness-to-pay values from MS patients as a proxy for how well-informed citizens might evaluate MS if they had a more realistic image of what having MS would be like.

Finally, aside from the critique that it is not possible to obtain reasonable answers to willingness to pay questions, a view contrary to the evidence presented

in our study, some object to cost–benefit analysis on equity grounds. They object to permitting individuals who are willing or able to pay more dollars to achieve particular health outcomes to claim more resources for programs that potentially affect them. Pauly (1995) (p. 109) has argued persuasively that this view has little merit because it generally should be possible to adjust willingness-to-pay estimates for the effect of income. In our analysis, we found that willingness-to-pay relates to income in the expected direction with data from the low-probability risk–dollar scenario, but this relationship did not hold for the high-probability risk–dollar scenario [13].

The respondents with MS had a somewhat higher willingness to pay to avoid the intangible loss associated with the disease—roughly half of which was attributable to higher income, more education and other differences between those with MS and the general public, even after adjusting for the higher extent of overestimation of the probabilities by MS subjects.

Whose preferences matter depends on the question being asked. If the question concerns research funding financed by general revenue, then the estimates from the general sample are germane (see Torrance, 1986). Although preferences of persons with MS should be reflected in the willingness to pay estimates, properly weighted, they represent a very trivial fraction of the sample. However, for purposes of selecting among alternative therapies, estimates of value from the inflicted persons are relevant. Some object to permitting individuals who are willing or able to pay more dollars to achieve particular health outcomes to claim more resources for programs that potentially affect them. In our analysis, we found that willingness-to-pay relates to income in the expected direction with data from the low-probability scenario, but this relationship did not hold for either the high-probability risk–dollar scenario or the risk–risk scenario. Thus, in the case of MS, it is not clear that an adjustment for income or education differences is merited even on positive grounds.

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[13] It did not hold for the risk–risk scenario either, but that is because we used the same value of life figure to convert risk of death estimates. Since those with higher incomes have more to lose from both death and MS, it is not necessarily surprising that their willingness to risk death to avoid MS was no different than the general population. Given that value of life estimates have been previously shown to vary with income in some studies, we could have used a higher value of life figure for the high income group, in which case the risk–risk willingness-to-pay estimates also would have related to income in the expected direction.

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