

## **Willingness to Pay for Food Safety: Sensitivity to Duration and Severity of Illness**

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## **Abstract**

The vast majority of foodborne-illness cases result from exposure to pathogens and cause only short term illness, yet research on economic valuation of health risk is dominated by the study of mortality risk. To help fill this gap, we provide new stated preference estimates of the value of reducing the risk of illness from foodborne pathogens with a focus on short term morbidity.

Our survey was administered over the internet to a panel randomly recruited from the adult United States population by Knowledge Networks and yielded about 3,500 completed surveys. Illness was described by a full factorial design that varied duration (1, 3, or 7 days), severity (three levels ranging from upset stomach to an illness requiring hospitalization), mortality risk conditional on illness (zero, 1/10,000, 1/1,000), and food type (chicken, ground beef, packaged deli meat). The reduction in risk associated with purchasing a safer brand of food varied between 1/10,000 and 3/10,000 per meal.

Estimated median WTP per case avoided ranges from about \$8,300 to \$16,400 to reduce risk to the adult respondent and from \$23,600 to \$30,500 to reduce risk to his or her child. Estimated WTP increases with duration and severity of illness, reduction in risk, and is higher for chicken than for ground beef and packaged deli meat. WTP to reduce mortality risk is estimated imprecisely but is comparable to accepted estimates. WTP is larger for women, respondents who observe safe food handling practices, perceive their own risk to be higher than average, and older respondents, but smaller for those who have primary responsibility for preparing households meals.

## **Introduction**

There is a mismatch between the incidence and economic valuation of foodborne illness. The vast majority of cases results from exposure to microbial pathogens (e.g., *E. coli* O157, *Salmonella*) and cause only short-term illness that lasts from one to a few days. Yet research on valuation of health risk has been dominated by the study of mortality risk. Economic Research Service and other estimates of the value of reducing morbidity risk have been forced to rely on cost-of-illness measures that include productivity and medical costs but exclude pain and suffering, lost leisure time, disruption of daily activities, and other components. To help fill this gap, we provide stated-preference estimates of the value of reducing risk of foodborne illness, focusing on short-term morbidity.

We design and conduct a stated-preference survey to estimate willingness to pay (WTP) to reduce the risk of foodborne illness of specified severity and duration. The following sections describe the survey instrument, sample, and results. We find that the value per statistical case avoided is larger for risk to children (\$23,600 – \$30,500) than to adults (\$8,300 – \$16,400) and is surprisingly insensitive to duration (1 – 7 days) and severity of illness (mild discomfort to hospitalization). Estimated WTP is larger for women, Blacks, Hispanics, and respondents who observe safe food-handling practices or perceive their risk to be higher than average and larger for risks transmitted on chicken than on ground beef or packaged deli meat.

## **Survey Instrument and Sample**

The survey instrument is organized as follows. First, respondents are asked about their experience with foodborne illness and their perception of how common it is in the United States. Second, they complete a tutorial designed to help them practice making tradeoffs between food price and safety. The tutorial introduces a visual aid to help communicate risk. The visual aid contains red and white areas representing 10,000 meals, where the fraction colored red equals the probability of illness (Corso, Hammitt, and Graham 2001).

Third, respondents are asked to consider buying food for a meal that only they will eat, randomly selected from {chicken, ground beef, packaged deli meat}. After answering questions about their typical consumption frequency and serving size (respondents who do not eat the selected food are asked about another), respondents are told their baseline probability of illness ( $2 \times 10^{-4}$ ,  $4 \times 10^{-4}$  per meal), the symptoms associated with illness (mild, moderate, severe),<sup>1</sup> duration (1, 3, 7 days), conditional mortality risk (0,  $10^{-4}$ ,  $10^{-3}$ ), and informed that they could reduce their risk to  $1 \times 10^{-4}$  per meal by purchasing a safer but more expensive type of food. The baseline and reduction in probability are communicated using the visual aid described above. The risk reduction is described as produced by a stringent safety program established and monitored by the United States government that does not use chemicals or irradiation (which some respondents may believe would present other risks). WTP to reduce the probability of illness is elicited using double-bounded, dichotomous-choice questions (Hanemann, Loomis, and Kanninen 1991) with initial bids ranging from \$0.04 to \$4.00 per meal and follow-up bids equal to twice or half the initial bid as appropriate. After the valuation questions, respondents answer follow-up questions about their food-handling practices, acceptance of the hypothetical scenario, and personal characteristics.

Each respondent values two risk reductions that differ by reduction in probability of illness, severity and duration of symptoms, conditional mortality risk, and food (chicken, ground beef, packaged deli meat). Attributes are randomly assigned using a full factorial design. Respondents living in a household with a child aged 2 – 18 years value

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<sup>1</sup> Mild: “You will have an upset stomach and will feel tired, but these symptoms will not prevent you from going to work or from doing most of your regular activities.” Moderate: “You will have an upset stomach, fever, and will need to lie down most of the time. You will be tired and will not feel like eating or drinking much. Occasionally, you will have painful cramps in your stomach. In addition, you will have some diarrhea and will need to stay close to a bathroom. While you are sick, you will not be able to go to work or do most of your regular activities.” Severe: “You will have to be admitted to a hospital. You will have painful cramps in your stomach, fever, and will need to spend most of your time lying in bed. You will need to vomit and will have severe diarrhea that will leave you seriously dehydrated. Because you will be unable to eat or drink much, you will need to have intravenous tubes put in your arm to provide nourishment.”

one risk to themselves and one to a randomly selected child in the household (in random order); other respondents value two risks to themselves.

To test for framing effects, respondents complete a version of the survey with risks and costs expressed per meal (as described above) or per month (converted from per-meal values using respondent-reported consumption frequency). If WTP is proportional to probability reduction, estimated values per case will be the same.

The survey was fielded to 6,368 randomly-selected members of a demographically representative panel maintained by Knowledge Networks. Households were recruited to the panel using random-digit dialing and provided free Internet access and hardware as a participation incentive. In total, 3,902 interviews were completed in several waves between August and October 2004, yielding a response rate of 61 percent. We exclude 136 respondents who do not eat any of the three foods ( $N = 107$ ) or declined to answer the WTP questions ( $N = 29$ ), leaving 3,766 respondents for analysis.

## **Results**

This section describes respondent characteristics and how estimated WTP varies with risk and respondent characteristics.

### *Respondent Characteristics*

Descriptive statistics are reported in the first column of table 1. Statistics for the subsamples of respondents living in households with and without children are similar to the full sample except age (mean 37 and 48, respectively), married (68 and 48 percent), household size (3.6 and 2.2), and college degree (21 and 27 percent).

On average, respondents estimate that 33 percent of the United States population contracts foodborne illness in a year, roughly compatible with an official estimate of 76 million cases per year (Mead et al. 1999). Respondents are significantly more likely to eat chicken and ground beef than packaged deli meat, which results in 40, 35, and 25 percent of respondents answering their first question about chicken, ground beef, and packaged deli meat, respectively. Most respondents report taking precautions when preparing food: 62 percent report consistent hand washing and 67 percent report taking one or more recommended steps to ensure that food is fully cooked or otherwise safe to eat. In

questions relating to acceptance of the hypothetical scenario, 48, 39, and 13 percent of respondents perceive their risk of foodborne illness to be similar to, smaller than, and larger than that presented in the survey, respectively.

*Effects of Risk and Respondent Characteristics on WTP*

We model WTP as a function of the severity and duration of illness, reduction in probability, and respondent characteristics. Regression models are estimated assuming a lognormal error term and using maximum-likelihood methods (Alberini 1995). We estimate separate models for WTP to reduce own risk for respondents with and without children in the household and for WTP to reduce a child's risk. Results are in table 1. We first describe Models 1, 3, and 5, which include only risk characteristics and then Models 2, 4, and 6, which add respondent characteristics.

For respondents in households without children, WTP to reduce own risk increases with reduction in probability of illness, symptom severity, duration, and conditional mortality risk (Model 1). Estimated WTP is 35 and 47 percent larger for moderate and severe than for mild symptoms<sup>2</sup> (the difference between WTP for moderate and severe symptoms is not statistically significant). WTP is only modestly sensitive to duration; compared with one day, it is 29 percent larger for seven and 6 percent larger (not significant) for three days. Estimated effects of conditional mortality risk are not significant, but the point estimates imply a value per statistical life (VSL) of \$9 – 25 million,<sup>3</sup> which is somewhat larger than conventional estimates (e.g., \$7 million, Viscusi and Aldy 2003; \$5.4 million, Kochi, Hubbell, and Kramer 2006). WTP is significantly greater for the larger reduction in probability of illness but the proportionate increase (1.85) is significantly smaller than the three-fold increase required by conventional theory (consistent with most stated-preference studies: Hammitt 2000; Hammitt and Graham 1999). In contrast, estimated WTP per month is 5.85 times larger than per meal. This

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<sup>2</sup> *I.e.*,  $\exp(0.297) - 1 = 35$  percent;  $\exp(0.387) - 1 = 47$  percent.

<sup>3</sup> Estimates derived by adjusting values per case reported in table 2 for mortality risk. E.g., estimated value per mild one day case is \$8,300 with no mortality risk and  $\exp(0.121)$  larger (i.e., \$9,400) with conditional mortality risk of  $10^{-4}$ . Implied VSL =  $(\$9,400 - \$8,300) / (10^{-4}) = \$10$  million.

ratio is nearly equal to the average frequency of consumption (5.68), which suggests that estimated values of risk reduction are not sensitive to the alternative framing.

For respondents living in households without children, estimated WTP to reduce own risk is less sensitive to the risk characteristics. In Model 3, the estimated coefficients of the risk-reduction, duration, severity, and mortality-risk variables are smaller than the corresponding estimates for households without children (Model 1) (except the coefficient on severe symptoms is negligibly larger). Standard errors are larger, in part because of the smaller sample size, and only the coefficients on severe symptoms and the per-month framing differ significantly from zero. Similarly, estimated WTP to reduce risk to a child (Model 5) is insensitive to duration, severity, and mortality risk, with estimated coefficients of these variables smaller than the corresponding estimates in Model 1 (except the coefficient on 3 days duration is negligibly larger). The estimated coefficient on risk reduction is significantly greater than zero but also significantly smaller than required for WTP to be proportional to risk reduction.

Models 2, 4, and 6 supplement the basic specification with variables that describe respondent characteristics. Coefficients of the risk-characteristic variables are not substantially altered. All three models suggest that estimated WTP is larger for respondents who are female, Black, Hispanic, or have no college degree. The estimated effects of income and marital status are insignificant and there is modest evidence that WTP increases with respondent age and decreases with age of the child to be protected. Respondents' perceptions of risk and confidence in protection mechanisms show significant effects: Estimated WTP is generally larger when own or child's risk is perceived to be larger than average and smaller when risk is perceived to be smaller than average (though only four of six relevant coefficients are significant). Estimated WTP is smaller for respondents who are not confident the hypothetical safety system would be effective. Among respondents in households without children, estimated WTP is larger when trust in the private sector is low and smaller when trust in government is low; in other words, WTP increases with the perceived need for and efficacy of a government program. Estimated WTP to reduce own risk appears larger for respondents who wash

their hands or practice other safe food-handling practices (perhaps reflecting greater concern for food safety) and smaller for those with primary responsibility for preparing meals in their households (four of six relevant coefficients are significant). There is evidence of an order effect, with WTP estimated from the second valuation question significantly larger than that from the first, except when the second question is about risk to a child. Finally, estimated WTP to reduce own risk, but not a child's risk, is significantly larger for chicken than for ground beef and packaged deli meat.

*Value per Statistical Case of Foodborne Illness*

Estimated WTP per statistical case avoided is reported in table 2. It is calculated by predicting median WTP for the full-sample-mean respondent for each severity-duration combination and dividing by the risk reduction.<sup>4</sup> For households without children, WTP to reduce own risk varies between \$8,300 and \$16,100 per case, increasing with both severity and duration (with standard errors of \$700 to \$1,200).

For households with children, WTP to reduce own risk is of similar magnitude but less sensitive to risk characteristics. The values per statistical case are larger for one and three-day episodes and smaller for seven-day episodes than for respondents in households without children. The range of values is correspondingly smaller, between \$10,800 and \$16,400 per case (with standard errors of \$900 to \$1,500).

WTP to reduce risk to a child is much greater than to reduce own risk but insensitive to severity and duration of illness. The value per statistical case ranges between \$23,600 and \$30,500 (with standard errors of \$6,600 to \$8,300, which are much larger than for adults). The estimated value per seven-day case is implausibly smaller than for shorter episodes because the estimated coefficient on seven-day duration is less than (though not significantly different from) zero. Controlling for severity and duration, the value per statistical case for a child is between 1.7 and 2.6 times as large as for an adult for households with children.

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<sup>4</sup> The estimated value per statistical case is calculated for each of the two probability reductions then averaged.

**Conclusion**

Our stated-preference estimates suggest that WTP to reduce risk of short-term morbidity from foodborne pathogens is on the order of \$10,000 per statistical case avoided for adults and twice as large for children. Estimated WTP is surprisingly insensitive to severity and duration of illness, especially for children. This insensitivity is unlikely to reflect respondents' unfamiliarity with these attributes or inattention to details of the scenarios given the significant association of WTP with stated risk reduction, a much more difficult attribute to grasp.

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**Table 1. Descriptive Statistics and Regression Estimates**

Variable	Mean (Std. dev.)	WTP to reduce risk to self				WTP to reduce risk to child (N = 1,149)	
	Full sample (N = 3,766)	Households without children (N = 4,934)	Households with children (N = 1,160)	Model 3	Model 4	Model 5	Model 6
Intercept		0.058 (0.114)	-0.827 (0.535)	0.623** (0.246)	-0.380 (1.115)	1.185*** (0.245)	2.835** (1.192)
Risk reduction = $3 \times 10^{-4}$		0.616*** (0.081)	0.666*** (0.078)	0.202 (0.162)	0.280* (0.158)	0.453*** (0.166)	0.459*** (0.162)
Moderate symptoms		0.297*** (0.098)	0.292*** (0.094)	0.214 (0.199)	0.190 (0.193)	0.041 (0.206)	0.119 (0.201)
Severe symptoms		0.387*** (0.098)	0.406*** (0.094)	0.389** (0.198)	0.417** (0.192)	0.034 (0.201)	0.123 (0.197)
3 days illness		0.058 (0.097)	0.055 (0.093)	-0.058 (0.196)	-0.062 (0.189)	0.081 (0.203)	0.080 (0.197)
7 days illness		0.251*** (0.097)	0.257*** (0.094)	-0.055 (0.200)	-0.044 (0.195)	-0.114 (0.204)	-0.053 (0.199)
Conditional mortality risk = $10^{-4}$		0.121 (0.097)	0.143 (0.093)	-0.052 (0.199)	-0.121 (0.193)	-0.085 (0.202)	-0.087 (0.195)
Conditional mortality risk = $10^{-3}$		0.032 (0.098)	0.056 (0.095)	0.005 (0.197)	-0.124 (0.192)	-0.272 (0.203)	-0.228 (0.198)
Monthly version	0.283 (0.450)	1.767*** (0.089)	1.779*** (0.087)	1.681*** (0.179)	1.723*** (0.174)	1.637*** (0.182)	1.746*** (0.178)
Age (years)	44.738 (16.306)		0.010*** (0.003)		0.007 (0.008)		0.017** (0.009)
Child age (years) <sup>a</sup>	8.462 (4.885)						-0.032* (0.018)
Male	0.475 (0.499)		-0.420*** (0.083)		-0.251 (0.180)		-0.539*** (0.189)
Male child <sup>a</sup>	0.530 (0.499)						-0.010 (0.161)

Black, non-Hispanic	0.110 (0.313)	0.862*** (0.136)	1.210*** (0.291)	0.833*** (0.286)
Hispanic	0.121 (0.326)	0.616*** (0.133)	0.723*** (0.238)	0.552** (0.241)
Other race, non-Hispanic	0.038 (0.191)	-0.103 (0.209)	-0.029 (0.401)	-0.219 (0.382)
Married	0.542 (0.498)	-0.135 (0.088)	0.045 (0.191)	-0.047 (0.200)
Household size (number)	2.596 (1.357)	0.028 (0.040)	0.013 (0.060)	0.020 (0.062)
Log household income	10.442 (0.944)	0.031 (0.046)	0.040 (0.097)	-0.151 (0.103)
College degree	0.247 (0.431)	-0.355*** (0.092)	-0.478** (0.205)	-0.461** (0.211)
Perceived prevalence (percent)	32.717 (23.227)	0.013*** (0.002)	0.001 (0.004)	0.002 (0.004)
Perceive own risk to be higher	0.134 (0.340)	0.392*** (0.126)	0.649*** (0.255)	
Perceive own risk to be lower	0.389 (0.488)	-0.276*** (0.085)	-0.259 (0.174)	
Perceive child's risk to be higher <sup>a</sup>	0.155 (0.362)			0.341 (0.252)
Perceive child's risk to be lower <sup>a</sup>	0.344 (0.475)			-0.646*** (0.179)
Prior foodborne illness	0.379 (0.485)	-0.207** (0.082)	0.021 (0.164)	-0.015 (0.167)
Not confident in safety system	0.159 (0.365)	-1.041*** (0.117)	-0.629*** (0.239)	-0.516** (0.242)
Somewhat confident in safety system	0.490 (0.500)	-0.041 (0.087)	-0.298* (0.177)	-0.211 (0.182)

Low trust in government	0.041 (0.199)	-0.706*** (0.204)		0.120 (0.448)		-0.183 (0.459)
Low trust in private sector	0.061 (0.240)	0.485*** (0.178)		-0.073 (0.385)		-0.213 (0.393)
Ground beef	0.346 (0.476)	-0.376*** (0.092)		-0.460** (0.194)		0.256 (0.201)
Packaged deli meat	0.248 (0.432)	-0.321** (0.130)		-0.577** (0.289)		-0.352 (0.287)
Monthly consumption frequency (number)	5.679 (6.310)	0.009 (0.006)		0.017 (0.014)		
Monthly consumption frequency – child (number) <sup>a</sup>	5.923 (6.426)					0.028** (0.013)
Responsibility for preparing meals (0 – 4)	2.356 (1.472)	-0.098*** (0.031)		-0.012 (0.067)		0.016 (0.071)
Wash hands	0.617 (0.486)	0.423*** (0.080)		0.528*** (0.164)		0.080 (0.169)
Safe food practices	0.674 (0.469)	0.220* (0.118)		0.082 (0.262)		-0.400 (0.272)
Second risk		0.187** (0.077)		0.584*** (0.160)		-0.166 (0.161)
Residual geometric standard deviation	2.310 (0.050)	2.179 (0.047)	2.257 (0.101)	2.134 (0.095)	2.205 (0.104)	2.082 (0.098)
Log likelihood	-5,501.9	-5,262.2	-1,279.2	-1,231.0	-1,136.2	-1,095.5

Notes: Variables are 0 – 1 and individual characteristics are for respondent except as noted. Mean and standard deviation of child characteristics are for households with children. Regression standard errors are in parentheses. \*\*\*, \*\*, and \* denote statistical significance at 1, 5, and 10 percent, respectively, using likelihood-ratio tests.

**Table 2. Estimated Value per Statistical Case of Foodborne Illness (US\$)**

Severity	Duration	Adult case				Child case	
		Households without children		Households with children		Median	Std. Err.
		Median	Std. Err.	Median	Std. Err.		
Mild	1 day	\$8,300	\$700	\$10,800	\$900	\$24,900	\$7,000
Moderate	1 day	\$11,100	\$900	\$13,100	\$1,100	\$28,000	\$7,700
Severe	1 day	\$12,500	\$1,000	\$16,400	\$1,300	\$28,100	\$7,600
Mild	3 days	\$8,800	\$700	\$10,200	\$900	\$27,000	\$7,400
Moderate	3 days	\$11,700	\$1,000	\$12,300	\$1,100	\$30,400	\$8,300
Severe	3 days	\$13,200	\$1,100	\$15,400	\$1,300	\$30,500	\$8,300
Mild	7 days	\$10,800	\$900	\$10,400	\$1,000	\$23,600	\$6,600
Moderate	7 days	\$14,400	\$1,100	\$12,500	\$1,300	\$26,500	\$7,500
Severe	7 days	\$16,100	\$1,200	\$15,700	\$1,500	\$26,700	\$7,300

Note: Estimates are based on predicted median WTP for full-sample-mean respondent using Models 2, 4, and 6 (Table 1).